

*Robert* THE *Melville* 1764  
**FIELD ENGINEER.**

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**M. le Chevalier DE CLAIRAC,**

**Translated from the FRENCH,**

**WITH**

**OBSERVATIONS and REMARKS**

**on each CHAPTER.**

**TOGETHER**

**With the Addition of several NEW FIGURES, on  
a large Copper-Plate, to explain the AUTHOR'S  
CONSTRUCTIONS.**

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**By JOHN MULLER,**

**Master of the Royal-Academy at Woolwich.**

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®

FIELD ENGINEER

M. J. Chevalier



Observations on the

Remarks of

the Hon. the Secretary of the Admiralty

By JOHN R. M. L. A.

of the Royal Academy of Sciences

LONDON

Printed for John Murray, opposite the Admiralty

and Collier, Broad Street, London

TO  
**ROBERT NAPIER, Esq;**

Lieutenant General, and Adjutant General, of his MAJESTY's Land Forces.

S I R,

**Y**OUR favourable Opinion of this Author was my chief Motive to undertake the Work, and the constant Friendship you have honoured me with, during a long Series of Time, induced me to present it to your Patronage in an English Dress.

No one has a greater Aversion to flattery than myself, nor can I be suspected of it, when I say that few are better Judges, or more capable of distinguishing the Merit of this Work than yourself; as your amiable and disinterested Disposition has rendered you the Friend of all who have endeavoured to become

## DEDICATION.

become useful to the Public, especially in  
a Military Capacity, a grateful Acknow-  
ledgment is the least Return that can  
be made, by those who have had the  
Happiness to be patronized by you, and  
particularly by,

SIR,



*Your most Obligated,*

*and most Obedient*

*Humble Servant,*

**JOHN MULLER.**



THE  
EDITOR  
TO THE  
READER.

**T**HE Author of this Work, being an Engineer of high Rank in the French Army, had great Opportunities to improve his Knowledge; during a long Course of Experience, he considered, that though many have wrote upon the Construction of permanent Fortification, as well as upon the Attac and Defence of Places, yet little had been wrote in regard to the requisite Knowledge of an Engineer in the Field, which he very justly thinks to be full as necessary as any other Part; for which Reason, he imagined a Work of this Kind would meet with general Approbation; as he has wrote upon very little but what he has seen and ordered to be executed, and having besides,

## To the READER.

the Qualification of a good Writer, it is no wonder that his Work has been so much esteemed as to go through several Editions.

EVERY Officer may not be so well versed in the French, as to be able to read the Original, nor perhaps sufficiently acquainted with the Subject, it is hoped that a Translation, with proper Explanations, will prove acceptable. At the Beginning, where some Parts are expressed in a short and abrupt Manner, the Words wanting to render the Author's meaning more conspicuous, have been supplied; the same Liberty has been taken with the Author's Expressions, when necessary to render the Work more easy to Beginners. So that no strict literal Translation has been attempted.

I have added a new Plate, to explain those of the Author's Constructions, which few Readers would have understood from his own Words. And Notes by Way of Observations at the End of every Chapter, to explain and enlarge upon what has been treated upon in that Chapter. All possible Care has been taken to explain every Subject, in such a Manner, that any who have the least Skill in drawing may understand every Part of it.

PREFACE.

# P R E F A C E.

**T**HE Knowledge necessary for an Engineer is of two different Kinds, one speculative, demonstrable, and consequently invariable, serving as general Principles, and making Part of what is directly called Science; the other more practical and arbitrary, immediately comprehends the different Objects of his Profession.

WE have a sufficient Number of Treatises on elementary and practical Geometry, and on the Principles of Algebra; there are also good ones on Mechanics and Hydraulics.

If those Sciences, that is, those Parts of the Mathematics necessary to be known, previous to an Examination, were all that is necessary for the Theory, it is plain that all the Assistance requisite is to be had; but to imagine it thus confined, is not to know the Extent it may, or ought to have.

INDEPENDENT of this speculative, and preliminary Theory, there is a practical Part, which from Ideas, carefully examined, shews the most eligible Means of attaining the End proposed, and procures us the second Part of Knowledge necessary.

THOUGH these two Parts are equally necessary, we are as much at a Loss for the Means of acquiring one, as we are abundantly provided for the other.

THE Reason of this Difference is evident: To treat of speculative Knowledge, it is sufficient to under-stand



stand Geometry, but much Experience is necessary to give satisfactory Instructions on the practical Part; and though the Number of Engineers, capable of doing this, were equal to that of other learned Men, their Employment, which confines them to the frontier Towns, and finds them almost constant Work, allows them little Time to range their Ideas in order, much less the Means of giving them to the Public.

YET the speculative Theory, being only a Means by which we may arrive, by the shortest and surest Road, to the practical, and of all Military Employments, ours being subject to the greatest Variety, one may judge of what Importance that Assistance is, which we almost entirely want.

I say almost entirely, and a little Consideration on the Knowledge of this Kind necessary for an Engineer, will convince every one, that the Expression is not improper.

THIS Knowledge consists in the Fortification, Construction, or the Art of executing a Project with proper Solidity and Economy, the Attac and Defence of Places, and what regards Field Engineering.

I include Fortification, though I am not insensible it has its speculative Theory, that is, Principles, or rather Maxims, which serve for Rules; the same may be said of the Attac and Defence of Places, which are necessarily connected with those Maxims. Besides, those Maxims are not capable of Demonstration; and they are so dependant on the Situation, &c. of the Ground, and other physical Circumstances, that not judging them fit to be ranked among Sciences purely speculative, I thought I might place them in this Class.

ALL the different Parts of Engineering being relative to Fortification, which is without doubt the Principal; the different Parts of this Knowledge tending almost entirely to Fortification.

I F



## P R E F A C E.

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IF the Number of Books could supply their Quality, we certainly could desire no more upon this Subject? Most Authors have thought to reform the whole on new Ideas, by improperly changing the Inclination of one Line; others, to distinguish themselves more, have imagined the most monstrous Figures, induced thereto by the Easiness of the Performance.

WRITERS of all Degrees and Professions, even those most incompatible with Arms, have prescribed Methods and Rules, and this Jumble of useless Pieces have been honoured with the Name of System\*.

I know that among the Number of Authors, there have been Engineers of established and respectable Characters, such as the *Chevalier de Ville*, *Count de Pagan*, and *Baron Coeborn*; I am far from confounding them with the others, but it is evident their Design in writing was less to inform Pupils, than to attain some Ideas, either new, or essentially differing but little from what was already known, and approved by Connoisseurs.

WE cannot be surprized that in the vast Number of Books, there are not, perhaps, four worth reading on this Subject, and not one in which are found all the necessary Instructions which might be contained in a Treatise of a moderate Size.

CONSTRUCTION is an Art which includes such different Objects, and depends on so many Circumstances, that few Authors have treated of it, and none in a Manner sufficiently instructive, or extensive: We have nothing compleat in this Kind. An Engineer is often obliged, for his Instruction in so im-

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portant

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\* The *Count de Montecuculi* was much of the same Way of Thinking; he says, in *Book I. Chapter 5th*, "But how many different Combinations may be made of the reciprocal  
" Proportions

portant an Affair, to his own Mistakes, which are always attended with useless Expence.

WE are much more fortunate in regard to the Attac of Places : The Marechal de *Vauban* who invented, rather than perfected this Art, has wrote on it as extensively, as solidly : Since that valuable Manuscript has been printed in *Holland*, there is nothing essential to be wished for on that Head.

THAT great Man, in 1706, wrote a Treatise on the Defence of Places : Nothing indifferent can come from so masterly a Hand, the Work is worthy the Reputation of the Author ; but our Conquests, continuing almost without Interruption, not having given him an Opportunity of exercising his Talents on this Subject, as on the other, and it being an Object which consists chiefly in Chicanery, or Stratagem, and therefore subject to much more Variety, it is thought that nothing can be retrenched from the Work, but much may be added to it.

BESIDES this Manuscript (for I am not talking of what is published at the End of the Attac) is so scarce, that there is little Probability of its being soon printed.

THOUGH most of those, who have wrote on Fortification, have treated on that Part which concerns the Field, I may, without exaggeration, assert they have said nothing to the Purpose.

WHAT does it signify, in treating of such a Subject, to give a Plan and Profil of Lines in ordinary Ground,

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“ Proportions of those Parts ? How many Authors have  
 “ treated of them ? How different are their Discoveries ?  
 “ They are infinite and tiresome in those Authors, who  
 “ have been only Compilers, or copied one another, or  
 “ have only chimerical Ideas without Practice. — It is a  
 “ *Proteus*, changing into a Thousand different Forms.”



## P R E F A C E.

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Ground, to shew how to raise a Redout, or flank a Piece a little more extensive, often contrary to the Rules of right Reason.

THIS kind of Forgetfulness has proceeded from different Causes; Cabinet Authors, to whom the Combination of a few Angles and Lines, gave room to display their Skill in fortifying Places, not being able to treat of this Subject, founded almost entirely on Practice, by taking the most prudent Part, have abandoned it to its Professors.

THE Conquests of a Reign, for a long Time happy, were not Circumstances proper for perfecting an Art, whose principal Object is a defensive War. It must also be observed, that a Brigade of Engineers was then thought sufficient for an Army, this Brigade consisting only of six, and they generally employed.

THUS our Successes were an Obstacle to our Instruction; and it is not surprising, that in the small Number of Men that afterwards had an Opportunity of improving themselves, the Talent of arranging and expressing their Ideas, or an Inclination to publish them, have not been found united with the necessary Leisure and Experience.

AFTER shewing in what we are deficient, I may be allowed to offer a Remedy.

THOUGH Fortification of Places, important as it is in itself, and in its Connection with the other Parts of this Knowledge, is, to speak in general, that to which Engineers least apply.

THIS Indifference probably proceeded from their having learned it by rote, without Principles, which a Master little skilled in the Art renders respectable by the Name of the Author, from whom he borrows it; and which makes them consider it as confined, or already carried to its utmost Extent.

THAT a Science, so much neglected by those whose Interest it is to cultivate it, should have employed so many Pens, is a Consideration insufficient to remove this Prejudice, and I may venture to say, that the uninstrusive Uniformity, or disgusting Whims of so many different Productions can only confirm it, and give a Distaste to such a Study.

I D E A S more extensive, or more methodically ranged, learned at School, or immediately after, would give more Insight, and a better Taste for a Point so essential.

I could wish some Person of Capacity would begin, by explaining the different Parts which form the Front of a Fortification; for Example, to describe a Rampart, Ditch, Covert-way, explain their Uses, what should be their Heighth and Breadth, the Advantages attending their being encreased, or diminished; afterwards treat, with the same Attention, of the whole Inclosure, the different regular Figures, and the Outworks used to cover the Body of the Place; then shew how to draw a Plan after the principal Systems already known, examine them accurately, weigh their Advantages and Defects, and shew by the little Difference among those Systems, the small Progress yet made in this Art; then conclude by laying down general Maxims, and shewing how they ought to be applied to irregular Figures.

I am convinced such a Work would produce very different Notions and Ideas of Fortification, from the present ones; and was it better known, it is probable would be more cultivated.

I F Practice be indispensably necessary to form an Engineer, it is principally in regard to Construction; and though I own this Necessity, it cannot be denied that in this Case, as well as others, some well wrote Treatises would remove the greatest Difficulties. When personal Experience is necessary, but for want  
of

## P R E F A C E.

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of Opportunity cannot be obtained, is it not a great Advantage to be enabled to benefit by that of others?

How useful would a Collection of Instructions be, chiefly drawn from Projects and Schemes, and enriched with Plans, Profils, and Designs of the different Kinds of Works, erected in *France*, since the Establishment of the Body of Engineers? I may assert that, not only young Engineers, but others would be greatly improved from such a Work.

SUPPOSE, for Example, any one is directed to build a Bridge over a Precipice, or to construct a Sluice, or a Reservoir on a considerable River, what better Models could be followed, than what has been lately done at *Briançon* and *Mentz*.

ALL the necessary Materials might be found in the Engineer's, or public Offices, and in the Hands of the Directors. The Engineer charged with this important Work should draw all the Plans, and arrange and unite the different Parts, which should be furnished by those appointed for this Undertaking.

MANY excellent Works now hid, or forgot, would be then exhibited, be of lasting and public Utility, and save the Crown vast Sums, daily lavished on defective, or ill constructed Buildings.

IT is evident, that I suppose the Interposition of the Government, but can there be any doubt of its Assistance to carry so useful a Project into Execution.

A Copy of *Mareschal Vauban's* Memoirs, carefully compared with the original Manuscript, would be an excellent Basis for a compleat Treatise on the Attac of Places.

I would have joined to it, by Way of Commentary, all the Remarks and Additions that should be thought necessary. That Author's first Memoirs, some printed Books, the Writings of the best Engineers, and the most remarkable Passages, taken from the



the Journal of Sieges, would furnish ample Materials for such a Work.

THE same Method might be taken with that General's Memoirs on the Defence of Places, or, if thought necessary, it might be new modelled.

IN distinguishing, as I have done, the Attack and Defence of Places, from the Functions of a Field Engineer, it appears at first Sight, that the difference is so little as scarcely to be perceived, but Experience has convinced me of that Error, and I have imagined, that without quitting the Subject, Materials may be found for a Treatise, as full of Variety, as new, and instructive.

WHEN we consider, that of the five Parts of practical Theory, there is none, on which much more may not be said, there is no avoiding our surprize at a Neglect so prejudicial.

IT is certain, that what concerns the Construction cannot be clearly treated of, but by a well judged Collection of what the greatest Genius's have practised for several Years past, which requires the Assistance and Authority of the Government; but it might have been asked, and it is evident the same Excuse cannot be alledged for the other Parts.

IN vain do we seem to expect from other Hands that Assistance, which our Corps alone is capable of giving us: It must be an Engineer that can write well on this Subject, and I may venture to say, that being no less Men of Council than Military, it is not more honourable than advantageous to us, to leave to Strangers the Care of our Instruction.

THESE Considerations induce me to speak by Example; but proportioning my Task to my Leisure and Capacity, or, perhaps, enclined by the Novelty of the Subject, I at present confine myself to the ordinary Services of the Field, in which I have the Advantage of some Years recent Experience.

As

As Temporary, or Field Fortification, is the first and principal Part of this Service, its Theory shall be the Subject of this Volume.

IF it be well received, I may be induced to proceed, it shall soon be followed by a Treatise on Construction; and to render it more compleat, I will add, as far as possible, all the necessary Instructions, on the most minute Works, and the different Commissions, that an Engineer may be charged with in the Field: It is well known that this Kind of Construction, quite different from that of permanent Fortification, is neither less extensive, or varied; and I may say, that I have little to seek for on this Subject.

THE Instruction of our Body being my chief Motive, I shall gratefully receive any Hints that may be given for the Improvement of this Treatise, yet think it necessary to acquaint the Reader of a Point that requires his Indulgence.

WHICH is, the Necessity I am often under of speaking of myself; I know that such Quotations, particularly when they regard Sciences, are seldom excused, they are generally supposed to be the Overflowings of self Love, which wounds one's self, by arrogating a Kind of Superiority. The Case is therefore nice, but it should be considered, that there being scarcely any Thing wrote on this Subject, that could furnish me with Examples, I have been obliged to quote what I have seen, and put in Execution: That Field Fortification generally subsists but a short Time, and that Rank in which I served during the two last Wars, qualified me for such a Distinction, that I have seen little of this Kind, of which I had not the Charge.

I hope these Reasons will justify me, at least with the indulgent Reader; as to the others, they may if they please consider what I have wrote, only as a Relation,

## P R E F A C E.

Relation, accompanied with Reasonings, (and in a different Order from their Dates) of what I have seen or executed in this Kind : However this Error, if one, relative to the Author only, will not diminish the Utility of the Book.

I have little more to add : My Reason for putting a general Preface, before a particular Treatise ; if I am supposed not to design writing successively on the other Parts, it must be allowed, that it may be of Service in exciting other Engineers to it : Such a Motive justifies the rest ; and if it produces so good an Effect, may be more useful than this Work.

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The



# FIELD ENGINEER.

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## CHAPTER THE FIRST.

- I. *Of field fortification.* II. *Its particular maxims.* III. *Defects of saliant angles.* IV. *Means of correcting them.* V. *Redouts, their most perfect figure.* VI. *Their size and use.*

I.



THE art of fortifying, constructing, attacking and defending fortified places, comprehends the most essential and most shining parts of a good engineer; but, as there are many other things to be known when in the field, his studies should not be confined to these objects alone.

An army, intrenched with judgment, produces, in many respects, the same effect as a fortress; for it covers a country, supplies the

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want of numbers, stops a superior enemy, or obliges him to engage at a disadvantage.

On the other hand, being master of the field, there are posts, heads of bridges, quarters to secure, and many other works to construct.

The knowledge of a field-engineer being founded on the principles of fortification, it must be allowed, that the art of fortifying is as necessary to an army in the field, as in fortified places; but though the maxims are the same in both, yet the manner of applying and executing them with judgment, is very different.

A project of fortification is commonly the result of a long meditation; the engineer plans, digests, and examines it in his closet; he compares at leisure his different ideas, and, provided the work be solid and durable, he is not anxious about time, materials, or any other necessary means, which he knows are to be had in the execution. But in the field it is otherwise, no regard is to be had to the solidity of the works; every thing must be determined on the spot; the works are to be traced out directly, and regulated by the time, and number of workmen, depending on no other materials than what are at hand, or on other tools than the spade, shovel, pic-ax, and hatchet.

It is therefore in the field, more than any where else, that an engineer should readily know how to seize on all advantages at first sight,





## ENGINEER.

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fight, to be fertile in expedients, inexhaustible in inventions, and indefatigably active. Vivacity and fertility of genius, which are natural talents, are not sufficient, without the knowledge acquired by practice. To contribute to this knowledge as much as possible is the design of this work.

II. To begin, I shall add to those general maxims of fortification, which the reader is supposed to be acquainted with, some particular ones, by way of general rules.

*First*, to inclose within the work as much ground as possible, having regard to circumstances. This attention, which principally concerns redouts and small forts, is necessary for the guards of these works, to lodge themselves, and to move commodiously; on the other hand, that the troops may be less crowded in their camp, or different motions.

*Secondly*, if there are several works near each other, that their lines of defence are so directed, that they may defend each other, without annoying themselves by their own fire. The utility of the one, and the inconveniency of the other of these observations, are too evident to need an explanation.

*Thirdly*, not to depend on the defence of small arms, but where the soldiers can fire at right angles; because they generally fire without aim, and directly before them.

*Fourthly*, not to have recourse to the second flank, or fire of the curtain, but when there is an absolute necessity. This maxim

is a consequence of the former ; it will appear besides, in article III. of the next chapter ; that the real defence is not to be estimated by the length of the oblique flank, but by that of the perpendicular, let fall from its extremity on the line of defence.

*Fifthly*, that the flanking angle, that is, the angle which the flank forms with the line of defence, be always a right one, or more obtuse, but never to exceed 100 degrees, if possible ; because there is no fear here, as in a fortress, that the flank be too much exposed. Besides, it is not necessary to graze the faces, or even to fire obliquely on them ; since there is no danger of being exposed to the defence of a breach, or lodgement of the miners. The only thing to apprehend, is a sudden attack, commonly in column, by a superior enemy, difficult to resist, if once got over the ditch ; it is therefore necessary to stop him at some distance, to discourage him, and not to increase our own danger, by exposing us without necessity to our own fire ; which unavoidably happens, if the flanking angle be acute ; because in these moments of confusion, the fire is always badly directed ; yet, at the same time, the opposite extreme ought to be avoided, not to make the angle too obtuse ; for in this case, the fire does not so well defend the ditch ; it spreads too much, and does not cross, or very little, before the salient angle ; for these reasons, rather than the desire to lengthen the

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the flank, I prefer, when convenient, the angle of 100 degrees, to a right one.

*Sixthly*, that the flanking parts be sufficiently extended, so that the interior of their parapets at least rake the whole breadth of the opposite ditch. When the enemy is near, especially in column, a front fire seldom stops them; as the enemy is under cover, when in the ditch, from all other fire but that of the opposite flank, which therefore should be as long as possible.

*Seventhly*, never to make an advanced ditch in dry ground, unless it may be enfiladed throughout, and under a proper angle, to be defended by the work which it covers or furrounds.

Works, without flanks, such as redouts, and those whose flanks are too oblique, or not sufficiently extended, are the only ones which should not have advanced ditches\*.

*Eighthly*, not to allow more than from 60 to 80 fathoms for the lines of defence, when they proceed from two flanks separated by two branches, which form a saliant angle, or when not made to cross though produced.

As the flanked angle of polygons, designed by the first case, are the parts most exposed, they cannot be too well supported; the second particularly concerns † indented works,

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\* We have omitted a great part of this paragraph, as being of no use to explain the rest.

† *Cremailleres*, is rendered in English *indented*, as meaning



where the defences being parallel, and directed the same way, cannot cross each other, the fire of one flank ought to be doubled by that which precedes it; as may be seen in the article of lines.

*Ninthly*, that the parts most extended, and consequently the weakest in themselves, be as much defended as possible, and have at least the fire of two flanks, besides their own direct fire. Nothing can be plainer, than to defend that most, which wants it most.

III. All fortifications, suppose either a plane figure or a line only, that are or may be put into a state of defence. A line is not esteemed fortified, but as it is flanked; fortification therefore necessarily supposes angles, and consequently saliant ones.

If the saliant angles are formed by right lines, they have the advantage above others, of being defended and grazed in all parts: this must be clear to every one, yet in my opinion, their defects have not been minutely considered. The soldier generally fires mechanically, and consequently right before him; experience has so often convinced us of this, that it may be laid down as an axiom. It follows then, that at the point of each saliant angle, there is a considerable space which is not raked by any direct fire; for I look on

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one  
ing the same thing, viz. like the teeth of a saw, as may be seen in plate I. figure 4. where the covert way is indented.

one man that may be placed there, as nothing. That space is a circular sector, terminated by the sides of the angle produced, and the radius the utmost range of a musket shot; so that, if this angle be a right one, and the musket range 150 fathoms, there will be a space of about 17679 square fathoms, where the besieger has no fire in front to fear. It is from this knowledge, often very superficial, that trenches are conducted, as much as possible, on the prolongation of the capital, and that skilful officers direct their march, as well for the attack of the covert way, as for that of any other work. Plate I.  
Fig. 1.

IV. To remedy this defect, some engineers round these angles, which, in effect, disperses the fire equally every where: this method is preferable to the common construction; but the rounding being of little extent, for fear of lessening the place of arms, or the work, the fire becomes very small and scattering. Fig. 2.

As it is the capital, which is the most distant from the flanking parts, and has likewise most occasion to be defended, I would rather chuse to cut this angle off by a right line. Both these methods diminish the defect only; the following one remedies it effectually, and is easy in practice, at least in fortified places. Fig. 3.

Trace the interior part of the parapet, not in a right line, but indented, observing that one face of each redan be perpendicular, and the other parallel to the capital; a construction that seems the most advantageous, as Fig. 4.

two or three different defences are drawn from the same part.

It is not at all surprizing, that men of genius often hit upon the same thing, M. de la Fon, director of fortification of the maritime places in *Flanders*, shewed me, in 1740 at *Dunkirk*, a project of this kind, in tracing a covert way: M. de Verville, formerly chief engineer at *Rocroi*, to whom I had not mentioned it, shewed me the plane of a square redout, in 1741, then at the army upon the lower *Rhine*, wherein he had proposed to defend the angles in this manner. So useful a discovery cannot but do these gentlemen honour, and I hope they will not be displeased at my mentioning their names.

V. A redout is the smallest piece of fortification that is constructed; I comprehend under this name, every field-work, not flanked by itself; they are of two sorts, one with a parapet, the other a \* *Machicoulis*: this last is seldom used in the field, yet I have seen one in 1734, at a line of *Etelingen*; it was an exagon of timber-work, which served for an intrenchment, and guard-house to a more considerable work. Redouts with parapets are more frequently used; they serve in the defence,

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\* *Machicoulis*, is an old word, still applied to projections in old castles, and over gates of towns, left open above, to throw down stones, &c. but it is not easy to understand the author's meaning in applying this word to forts; nor do I think it very material to understand it, in the sequel of this work.



defence, and sometimes in the attack of places, and frequently in that kind of war, we are here treating of.

When there is no particular reason to the contrary, their form is commonly square, observing to oppose one or more sides to the places to be commanded. If the redout is within reach of some other works, such as a covert way, or lines, its faces must be turned so, as to be defended by these works. It is essential in this case, to join all together by a communication; besides the assistance and a secure retreat, obtained by this disposition, it has the advantage of not being attacked in the rear, but with great difficulty.

A communication, well made, may besides give right and left flanks to those parts by which the work is protected, as may be seen in chapter VII. It has been observed, what service it is to remedy the defects of salient angles in general, in regard to redouts, it is not only useful, but necessary.

From what has been said on this subject, we may conclude, that the surface which the piece rakes, or fires on, is to that which it does not, as the interior of the polygon, multiplied by the range of musket shot is, to the superficies of a circle, whose radius is the length of the shot; so that, supposing this range of shot always to be 150 fathoms, there is about a redout of 40 fathoms interior parapet, a space of 6000 square fathoms exposed

posed to its fire, and a little more than 70714 that are not.

As this rule is general, and the number of sides makes no difference, it may be thought that a circle has not more advantages than another figure; because it is only a polygon of an infinite number of sides: this demands some examination.

Although the space a ball passes through has no greater breadth than its diameter, yet as each man that fires takes up two feet in front, I shall suppose it sufficient to fire on a breadth of two feet.

If the redout has forty fathoms interior circumference, its fire will form 120 parallelograms, which touching each other by the extremities of the small sides, leaving between the great ones 120 sectors, which together form, as in the square, a circle of 150 fathoms radius.

Consequently, a circle may not only be considered as a polygon of an infinite number of sides, but as one of 120 only.

I agree to these facts, which prove the rule I laid down extends to circular figures; but I am likewise convinced, that this figure, is much preferable to the rectilineal one.

In the square, for example, there are only four spaces which are not defended; but each of them contain right angles, and consequently, near 17679 square fathoms; whereas, by this supposition, I have in fact 120 spaces not defended, but each is less than 590 fathoms

thoms superficies, and drawn from an angle of three degrees only \*.

However great this advantage may be, there is one much more considerable; it is, that all the points of the circumference of a circle, being equally disposed, the soldier posts himself indifferently throughout; which makes the spaces defended vary every moment, and the enemy is secured in no particular part.

We may then certainly conclude, that the round redout, though little or not at all used, is the most perfect we can form; that the fewer sides these works have, the more defective they are; and that the contents of the spaces not commanded being the same in all cases imaginable, the larger they are, the less this disadvantage is in proportion.

The circular figures, though preferable, cannot be used but on certain occasions; if, for example, it be required to fire on an object of small extent, without doubt a front must be opposed, whose fires will be parallel to each other; other circumstances require a mixt figure, but in all these cases, regard must be had to the defects of the angles.

The

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\* As 120 spaces, of 590 square fathoms, make 70800 fathoms, which is above four times the space 17679; and therefore the circular figure is less advantageous in that respect, than the square one; it is true, these spaces are more equally divided all round, than in the square, whereby one defect is in a manner recompensed by another advantage.



Plate II.

The most infallible method is, certainly that which we quoted at the end of the preceding article : the defect not only disappears by that ingenious means, but that part becomes yet stronger than the side itself, as the extent of its defence is equal to that of the diagonal ; yet as the face of the redan ought not to be much more than three feet, it appears difficult to execute it without some sort of revetement, which we have seldom time, or means to make in the field.

We then shall often find it necessary either to cut off the angle, or round it ; if the latter, the rounding should be as large as possible ; and it must be farther observed, that the flatter it is, the more it will throw the fire towards the capital.

VI. The size of the redout is sometimes determined by the nature of the ground, but more generally by the number of men destined for its defence.

A parapet is well lined with two men to every fathom ; this knowledge is necessary, but not sufficient to determine the subject of this article.

Forty men, for example, cannot, because of the banquet, be contained in the *Terreplein* of a square redout of five fathoms interior parapet for each face, and 160 will be too many for that of twenty fathoms in each side ; because in similar figures, that, whose side is four times less than another, has 16 times less contents.

Hence

# FIELD

The most infallible method is certain

that which we quoted at the end of the  
ceding article: the defect not only disappears  
by that ingenious means, but that part  
comes yet stronger than the field itself, and  
extent of its influence is equal to that of  
the original, and the face of the ribbon  
not to be distinguished from three feet, it  
being almost impossible to detect it without  
the instrument, which we have already  
mentioned, and is in the field.

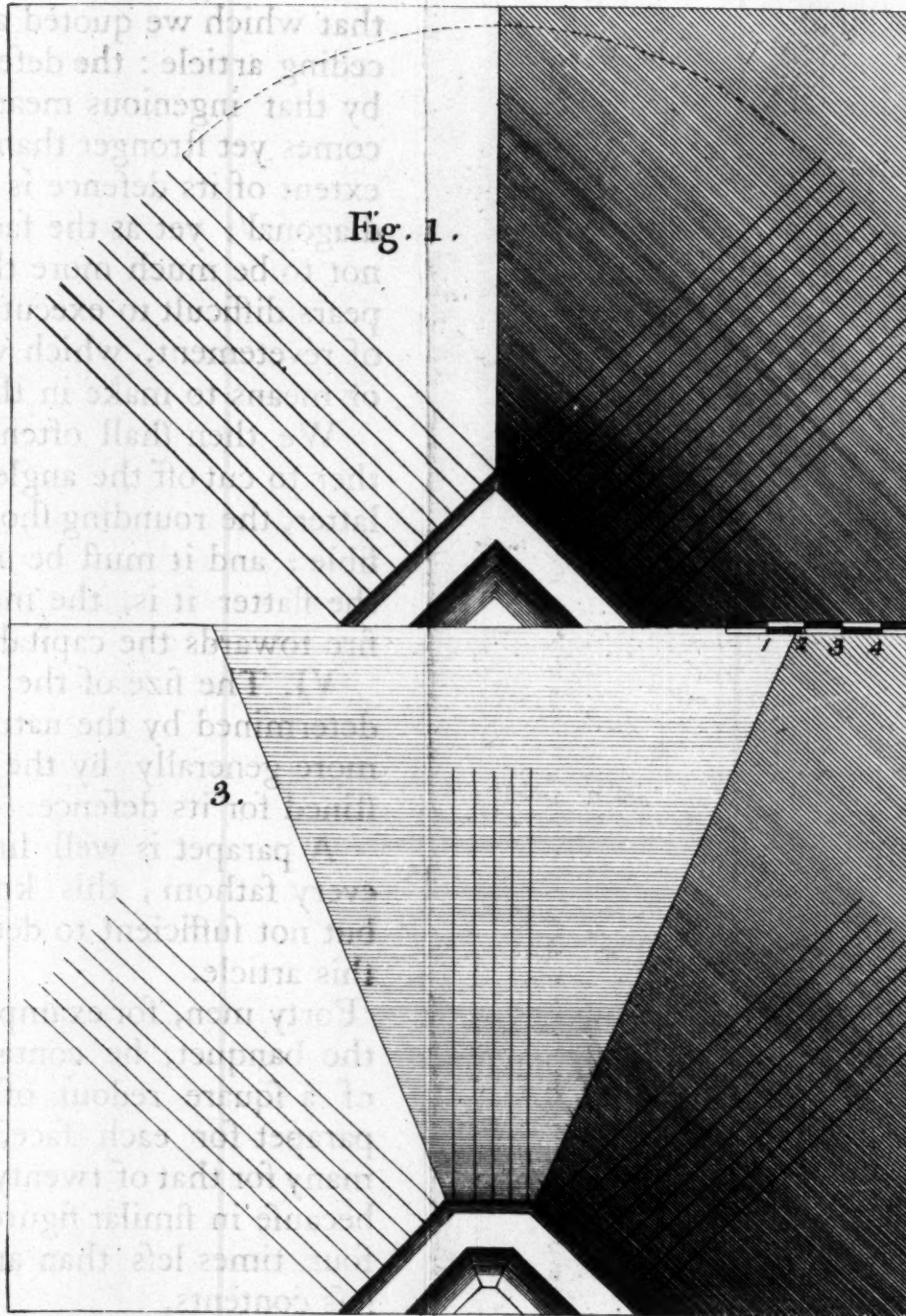
The small circle and its necessity  
to correct the angle, or round it, is  
the rounding should be retained as  
and it must be further observed, that  
if it is the more it will throw

towards the capital.  
VI. The face of the ribbon is sometimes  
determined by the nature of the ground,  
more generally by the number of men  
limited to its defence.

A parapet is well lined with two men  
every fathom; this knowledge is necessary  
but not sufficient to determine the subject  
of this article.

Forty men to the fathom cannot, because  
the parapet is contained in the force  
of the ribbon, and of its various angles  
at each fathom, and too will be  
found that of twenty fathoms each  
has to similar angles, that whole  
times less than another, has to

Fig. 1.



# SALLAN' ANGLES

Pl. 1. p. 7

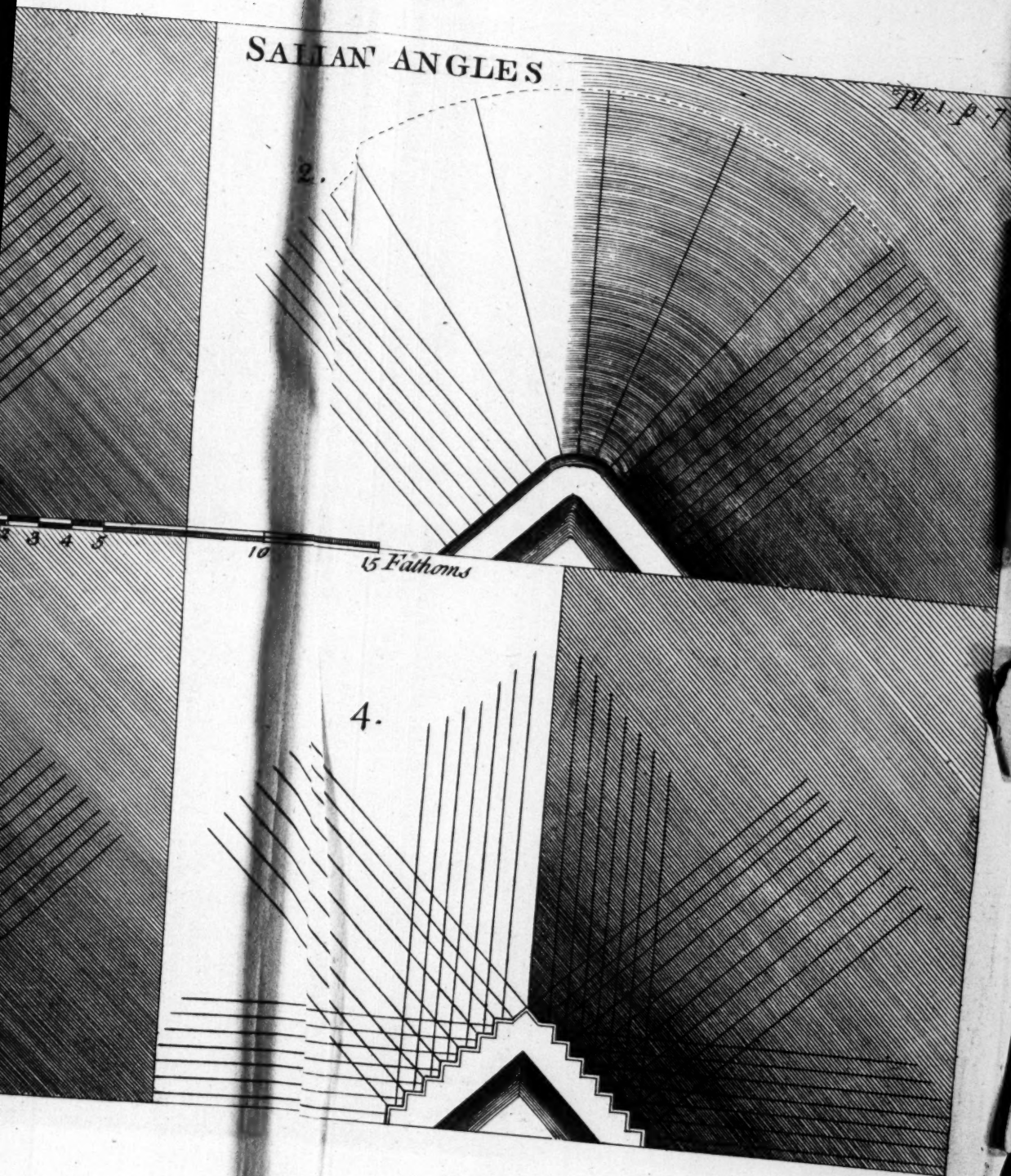
2.

10

15 Fathoms

4.

3 4 5





Hence regard must be had to the extent of the circumference, and to the surface at the same time.

A redout of twenty four fathoms parapet, that is, if it is a square of six fathoms interior parapet in each side, is the least that should be used.

On the contrary, they should not exceed 64 fathoms, that is, 16 in each side; for as these pieces have no flanks, it is better, when we would have a work of a considerable extent, to throw up little forts, which I shall treat of hereafter. A remark, which probably escaped the notice of the engineer, charged with the construction of the lines of *Etilingen*; for towards the extremity of the left, where we forced them, I saw a redout of about forty fathoms each side: in this gigantic piece was, that *Machicoulis* of timber, which I have already mentioned.

A redout of 24 fathom interior parapet will contain 36 men, and they are sufficient for its defence: that of 64 fathoms will not be crowded, and will be lined two deep with 256 men. But the numbers of 36 and 256 are the square of 6 and 16, that is, the fourth part of the extent of these pieces; we may then conclude, that if we quadruple the square root of the number of men, which may be destined for such works, it will give the extent of the circumference in fathoms.

If, on the contrary, the number of men a redout can contain be required, square the  
fourth

fourth part of the fathoms of its extent or circumference, and the product is the number.

For example, what dimensions should be given for 100 men? Multiply 10, the square root of a 100, by 4, it will give 40 fathoms for the extent of the parapets of all sides: on the contrary, multiply 10, the fourth of the extent, by itself, the product of 100 is the number.

Large redouts, by this rule, contain in proportion, more than the small ones; but this must be an advantage; since they are not constructed, but in places of importance, or those most exposed, and if it should be thought proper, the number may be diminished. This method is sufficient in practice for figures from 24 to 64 fathoms parapet; but it must be remembered, that the extent being equal, that which has most sides can contain the most.

The use of redouts in the field, is commonly to secure a post, a grand guard, or communication; to defend a defile, a bridge, or a ford; they may be useful also in flanking lines, as we shall see hereafter.

In some cases they may be necessary, to keep the enemy at a distance from some considerable post. In 1734, after the taking of *Philipsbourg*, we scarcely dared to graze our horses 100 fathoms from the pallisades; the hussars carried off, and killed an officer at the very foot of the *Glacis*, and the Imperialists, masters of that side of the *Rhine*, marched  
in

in broad day, and passed their baggage over the capucin-hill within cannon-shot of the place.

When I had repaired two old redouts on the side of the hill, and constructed a third; the hussars appeared no more, we kept our pasture, and they marched off through the wood.

#### OBSERVATIONS on the first CHAPTER.

The author, considering that engineers study chiefly the manner of building, attacking, and defending fortified places, and that the knowledge required in the field during a campaign, for the use and security of an army, has hitherto been much neglected, although not so shining, yet as useful as the attac and defence; for which reason he has published this work, as the result of a long experience and theory, built upon the most unexceptionable principles.

He begins with adding several maxims or general precepts, to those commonly laid down by writers upon fortification; and endeavours to correct some defects arising from the usual construction of the several parts of a fortification; one of the most considerable is, that all saliant angles have no direct defence, whereby the approaches are always made in the direction of their capitals, as being the least dangerous; to prevent which, and render that part as strong as any other, he makes the faces AB, CB not in strait lines

Plate A  
Fig. 1.  
as



as is the custom, but indented as is the face AB, in the following manner; draw AC and BD perpendicular to it; divide AB into any number of equal parts, and through these points of division draw lines parallel to AD and DB: these lines meeting each other at right angles, will form as many flanks to defend the angle B as are equal to AD; and therefore the angle B will be defended by a flank equal to AC, in the direction of the capital DB, and each face AB will be defended in the direction DA, by a flank equal to the perpendicular BD.

The author observes, that the parts parallel to AD, should generally have not above three feet, as being sufficient to place one man; it would be a difficult matter to support the earth on the inside without a brick wall, which is seldom to be done in the field; but as fods will answer the purpose full as well as bricks, in works of a short duration, this objection is of no consequence.

As each face parallel to AD is to its flank as AD is to DB; their proportion seems to be limited when the angle B is given, which in some cases may not be convenient; this may be obviated by drawing a line BE; and making the flanks on the side BC, parallel to that line; then they will be to their faces as BE is to DE; and the total defence of the angle B will be to the defence of BC, in a direction perpendicular to BE as twice DE is to BE.

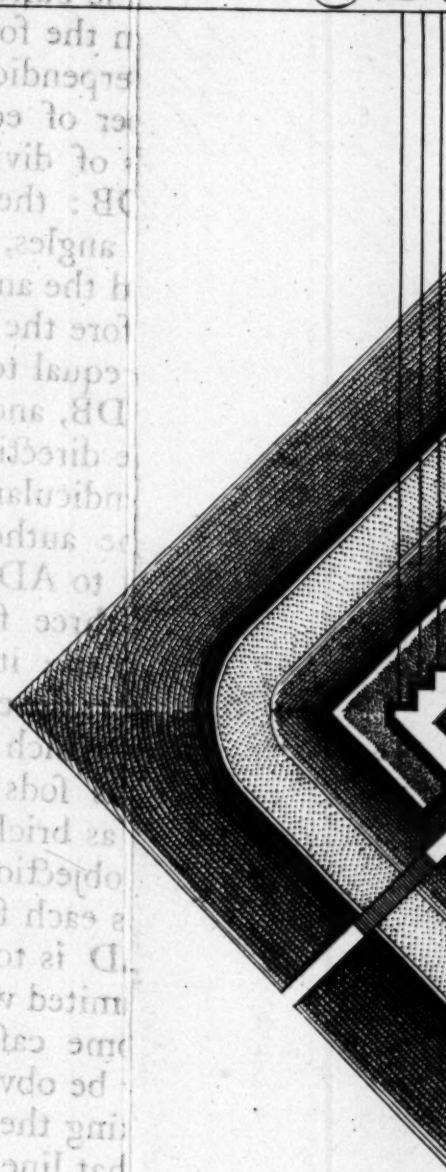
If

FIELD

in the following manner; draw AC and perpendicular to it; divide AB into any number of equal parts, and through these points of division draw lines parallel to AC; DB: these lines meeting each other at angles, will form as many triangles as the angle B as are equal to AD; and before the angle B will be divided equally to AC, in the direction of the DB, and each face AB will be divided in the direction DA, by a flank equal to the perpendicular BD.

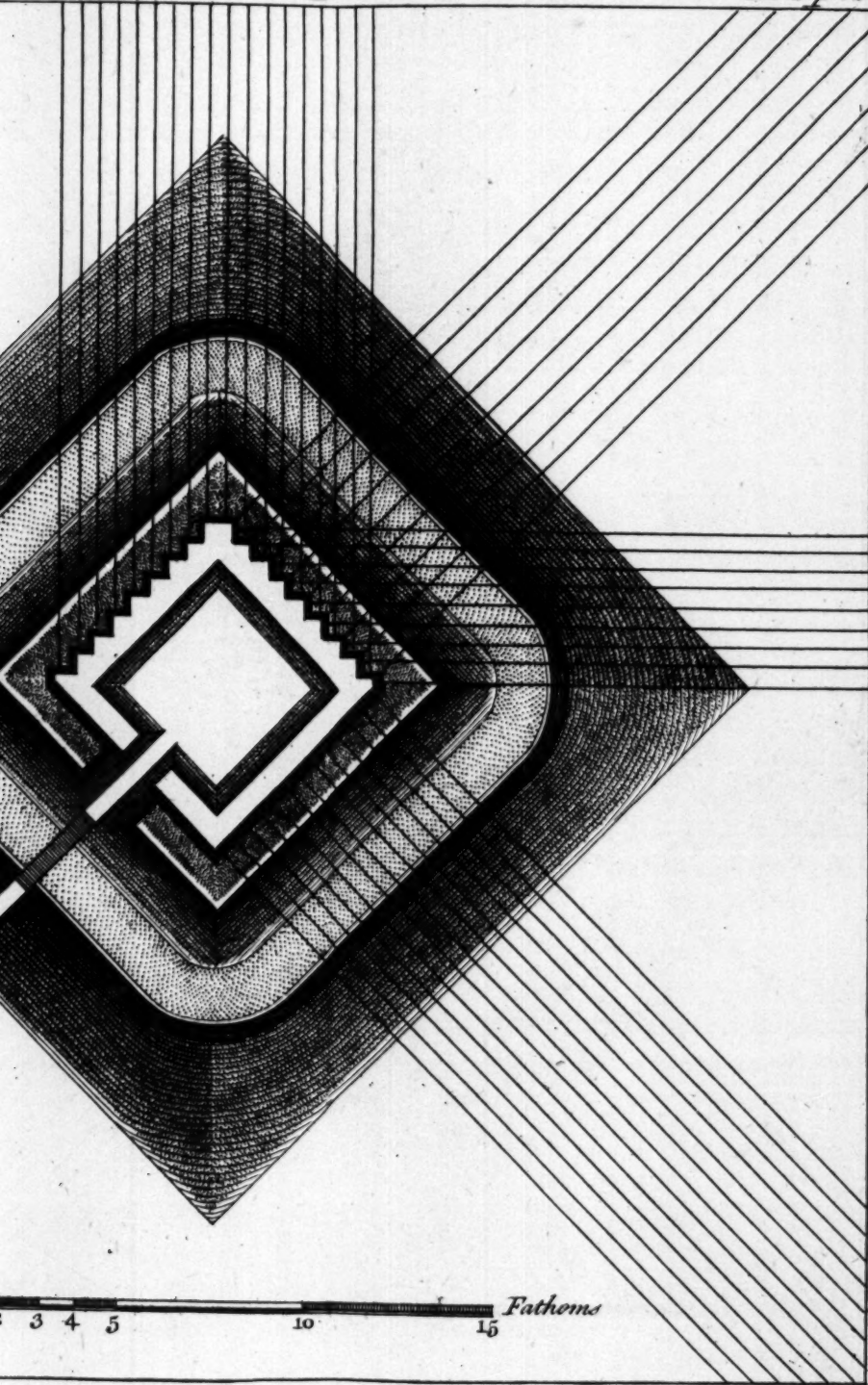
The author observes, that the part of the field to AD, should generally have not more than one face, as being sufficient to show it would be a difficult matter to ascertain on the inside without which it is seldom to be done in the field. The author will answer the purpose of the field as bricks in works of a short duration, objection is of no consequence.

Each face parallel to AD is to its flank as D is to DB; their proportion being united when the angle B is given, which some cases may not be convenient; this may be obviated by drawing a line BE, and joining the flanks on the side BC, parallel to that line; then they will be to their flanks as BE is to DE, and the total defence of the field B will be to the defence of BC, in proportion perpendicular to BE as twice DE to BE.



# INDENTED REDOUT.

Pl. 2. p. 12.







If the parapet of the covert way was thus indented, and the facet 8, 10, or 12 feet, and the flanks twice that length, without any traverses, the defence would, in my opinion, be better than when they are made in the usual manner; and then the covert way need be no more than five fathoms broad. For, when there are no traverses, the enemy would find no shelter when he has taken it, the troops placed in the redans could not be disturbed by the ricochet firing, and the motions would be more convenient. Besides, a piece of cannon might be placed in each redan, and thereby render the approach more dangerous. I know, that it is not customary to place cannon in the covert way; but, as it is the first work attacked, cannon placed there can defend it much better than from the bastions, by a grazing fire, and keep off the enemy at a greater distance, till such time that the covert way is in danger of being taken; they may then be removed to the inner works: besides, the present practice of the most experienced engineers is, to make the capital works as low as possible, to prevent them from being seen from the same batteries as the outworks; cannons in the covert way are in this case absolutely necessary.

Some engineers turn the salient angles into a circular arch, in order to get some direct fire, but as only one gun can be placed there, this practice remedies the defect but little; the author thinks it would be better to terminate

minate it by a right line; but even this is not sufficient without forming the parapet as described above.

In all square or triangular redouts, without bastions, the saliant angles cannot be defended from any part whatsoever, when their sides are right lines, and therefore are very defective, unless one of the fronts serves to defend some particular pass, and the ditch can be filled with water; for which reason, our author recommends the circular form, as preferable, though not hitherto used; because every part is equally defended. In either case, the slope of the parapet ought to be as great as conveniently can be done, without weakening it too much, the overplus of the earth, taken out of the ditch, should be laid on the outside in a glacis, to make the fire from the parapet more grazing; and when the ditch is dry, a row of palisades must be placed in the middle, and the parapet fraized.

The bigness of a redout is commonly determined by the figure of the ground, and by the number of men to defend it. It is supposed, that every man takes up three feet of ground; upon this supposition, it is easy to find the number of men to defend a work, placed two or three deep, from the length of the parapet at the inside. But our author observes, that this supposition is not just, because greater squares contain more room than small ones, in proportion to the squares

of



of their sides; and therefore the number of men should be in the same proportion.

The author supposes, that 36 men are sufficient to defend a square redout, whose interior side of the parapet is 6 fathoms; from whence follow these general rules. I. To find the number of men to defend a square redout without bastions; square the side expressed in fathoms, which gives the number of men required. Thus, if the inside is 12 fathoms, whose square 144 is the number of men required. II. The number of men to defend a redout being given, to find the side; extract the square root of the number of men, and you will have the interior side expressed in fathoms. Thus, if the number of men is 100, then the square root 10 will be the number of fathoms required.

If the number of men is not a perfect square, take the nearest root under that number. These rules are sufficiently exact in most cases; but as circumstances may vary, regard must be had to the importance of the post, and to the number of men an enemy may bring against it. It is not always sufficient, to line the parapet two or three men deep, but there must likewise be a reserve at hand, to replace those that are killed or wounded. It is therefore the duty of the commander, to regulate the number of men according as he judges it necessary.

## CHAPTER THE SECOND.

- I. *Field forts in general.* II. *Star forts.* III. *Second flanks.* IV. *Triangular and square forts.* V. *Heads of bridges.* VI. *Their figures according to different cases.* VII. *Those of a more durable construction.* VIII. *Scheme of moving flanks.* IX. *Other uses of armed boats.*

I. **S**MALL, or field forts, have the advantage of redouts, in being flanked, and the disadvantage in containing less within, in proportion to their extent.

We may consider them of two kinds : the one, defending itself on all sides, is entirely furrounded, and is what properly falls under this name ; the others, bordering on a river, precipice, &c. remain open at the gorge.

Some cabinet authors, for want of experience, have given pitiful designs on this subject, and sometimes engineers fall into gross mistakes, in the tracing them, for want of a proper attention.

These forts, as all the rest, are regulated by the general maxims and principles I have given ; observing in consequence of those maxims, never to construct a fort, under a certain size : it is better in that case to erect a redout, to preserve more capacity.

The size, and construction of these works differ, according to the manner in which they are to be fortified.

II. The

II. The most simple is, to \* brake the lines in reentrant angles, which gives oblique flanks, without shoulders.

By the general maxims I have established, we shall find, that the obliquity of these flanks, though often great, is only more or less defective as it exceeds the angle of 100 degrees; and no regard should be had to the dead, or reentrant angles which they form.

These are called star redouts, because they resemble that figure; *Adam Fritach*, who, on this subject, quotes the siege of *Breda*, says, they are commonly made of four angles, sometimes of five, and very rarely of six.

He constructs them by giving in the square Plate III. one eighth, and in the pentagon one sixth of Fig. 1, 2. the length of the side, to the perpendicular which forms the brake.

The flanking angle in one, is thus 152 degrees nearly, and more than 143 in the other: as they cannot be closed much more, no great protection must be expected from these flanks; yet the fire, crossing at a small distance, the polygon is without doubt better defended, than by a right line; but the saliant angles, especially in the square, are too much exposed.

I do not mention the difficulty of tracing a pentagon in the field, without instruments, because

\* To brake a line, is to make it with one or more angles, either saliant or reentrant; the line serving for the base. See the notes at the end of this chapter, where all the constructions given throughout this chapter are fully explained.



because every engineer ought to have always a needle by him, which is sufficient for that purpose.

Plate III. *Fritach* says nothing of the construction of  
Fig. 3. stars of six angles: *Father Dechaies* forms them of equilateral triangles; this figure is regular, and I believe the most perfect of its kind.

The flanking angle being thus 120 degrees, the fires cross better and nearer, and as the two flanks are on the same line, the space, not defended before the saliant angle, is reduced to a parallelogram, whose smallest side is equal to the gorge.

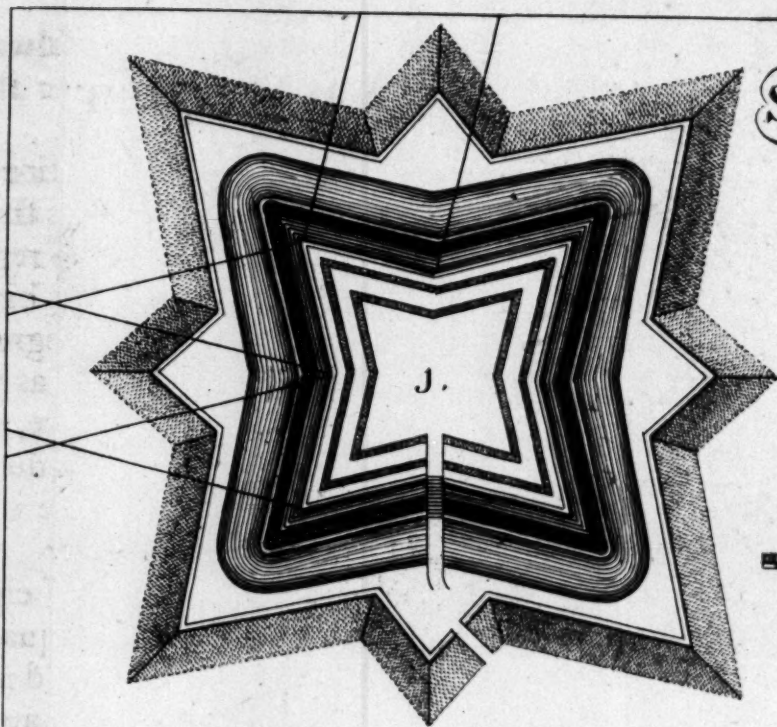
Plate IV. We may rank with these, stars of eight  
Fig. 4. points, which this ecclesiastic calls a square; it is in effect a square, where one third part of the side serves as a base to an equilateral triangle, which flanks the rest.

This figure, though irregular, has the advantage of the preceding one, in containing more space, and crossing its fires on the four right angles: as to the redans, the breadth of the space not defended, is as in the other, perpendicular and equal to the gorge.

If we compare these different figures, we shall find, that the defence increases, as well in front, as on the saliant angles, in proportion to the number of sides; therefore, contrary to the opinion of the *Dutch* author, the star of six points is preferable to that which has less, and that of eight points is preferable to that of six.

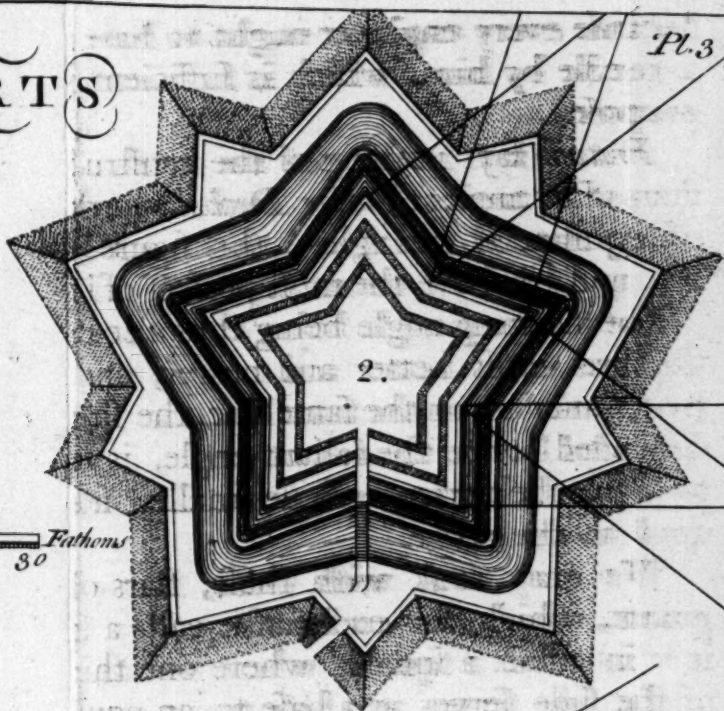
Their

STAR



# R FORTS

Pl. 3 p. 21.





CHAPTER II.

That most perfect combination of  
an equal side of an octagon, an equilateral  
triangle. The figure is regular, its flanked  
sides are 60 degrees, and its flanking  
which is not too much, but as it is not  
easy to trace this on the ground, the  
flank is very near it.

Blind the lines of a square, giving  
eight of the side to the perpendicular, and  
the flanking points, and elevate on  
front an equilateral triangle, the third  
of the eight sides forming a down-  
The flanked angles, by this, become  
ternatively 61 degrees 70 minutes, and  
degrees; and the flanking angles 105  
minutes. I executed this work in  
on the quick, and it was approved.  
I think they should be limited to the  
number of points; it is very difficult to  
them, and besides, useless to the defence,  
they have any more.

III. The construction of bastioned  
differs in nothing from that of places, except  
that the figure being smaller, and the  
supposed of another kind, it is reckoned  
incient to flank them with half bastion.  
The face of half bastions draw their  
defence from what we call the second flank,  
that is, from one part of the curtain,  
which we must make an essential observation  
I have shown, that the soldier remains  
then directly before him; though this is an  
important point, I will take no notice of it.

Their most perfect construction is, to form on each side of an octagon, an equilateral triangle. The figure is regular, its flanked angles are 60 degrees, and its flanking 105, which is not too much; but, as it is not very easy to trace this on the ground, the following comes very near it.

Bisect the sides of a square, giving one eighth of the side to the perpendicular, as in the star of four points, and elevate on each front an equilateral triangle, the third of one of the eight sides serving as a demi-gorge.

The flanked angles, by this, become alternately 61 degrees 56 minutes, and 60 degrees; and the flanking angles 105 degrees 58 minutes. I executed this work in 1743 on the queich, and it was approved.

I think they should be limited to this number of points; it is very difficult to trace them, and besides, useless to the defence, if they have any more.

III. The construction of bastioned forts, differs in nothing from that of places, except that the figure being smaller, and the attack supposed of another kind, it is reckoned sufficient to flank them with half bastions.

The face of half bastions draw their only defence from what we call the second flank, that is, from one part of the curtain; on which we must make an essential observation.

I have shewn, that the soldier generally fires directly before him; though this is an important point, I will take no notice of it

here, but suppose on the contrary, that he fires in the proper direction.

I shall not enquire into the advantages and disadvantages of the second flank, so much esteemed by the *Dutch*; such a discussion, though necessary, in a general treatise on fortification, would be misplaced here; I shall confine myself therefore, to the effect of this defence.

Plate V.  
Fig. 1.

So many authors approving of them, give room to think, that some of them suppose this defence to consist in the length of this part of the curtain, instead of which, it is reduced to the length of a perpendicular, let fall from its extremity on the line of defence.

Suppose two or three feet interval between each musket, the distance of a parallel to another being to be taken perpendicularly, it is evident, that the second flank will give no more fire than that perpendicular we have spoken of. That is, if the length of the second flank be 54 feet, and the flanking angle, as I suppose it in a triangular fort, 166 degrees 6 minutes, there will not be 13 feet real defence. The figure will explain this much better than words.

IV. This second flank, which, after all, we are obliged to have recourse to here, is smaller, and more oblique in the triangular figure than in the square; the triangular figure contains less in proportion, which is a disadvantage according to our maxims; for this reason, we avoid using them, if possible; yet  
as



I shall not enquire into the advantages of the second flank, to be determined by the Lines; such a determination, though necessary, in a general treatise on fortification, would be misplaced here; I shall confine myself therefore to the effect of distance.

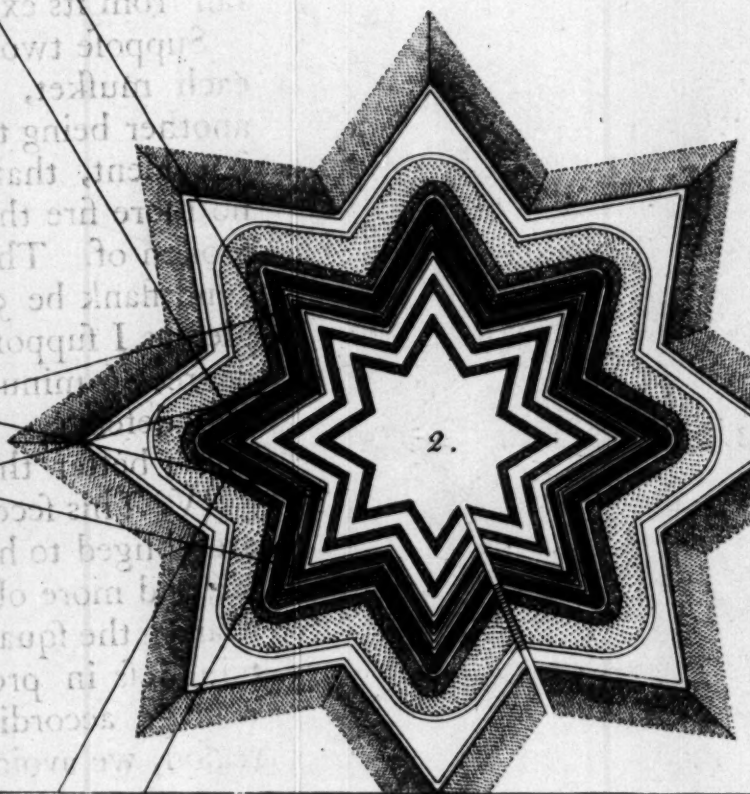
So many authors approving of them, seem to think that some of them improve the distance to consist in the length of part of the curtain, instead of which, it is added to the length of a perpendicular, or fall from its extremity on the line of defence.

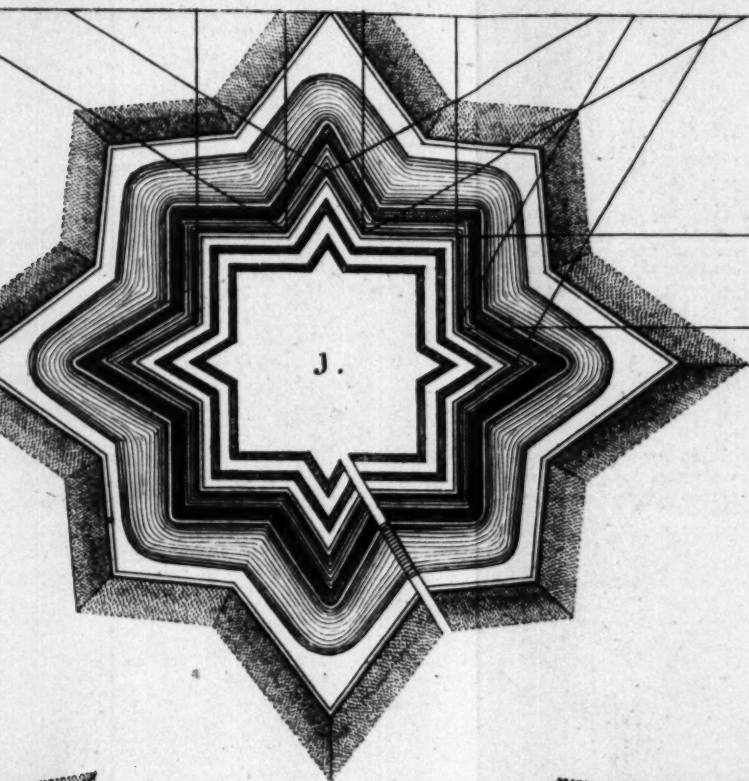
I suppose two or three feet interval between each flank, the distance of a perpendicular being to be taken perpendicular to the line, that the second flank will be more than the perpendicular we have lost. That is, if the length of the flank be 24 feet, and the flanking angle I suppose it is a triangular fort, the distance there will not be 13 feet. The figure will explain this in words.

The second flank, which, after all, is used to have recourse to here, is that more oblique in the triangular figure, the point, the triangular figure, in proportion, which is a disadvantage according to our maxims; for the more oblique, the more it is possible,

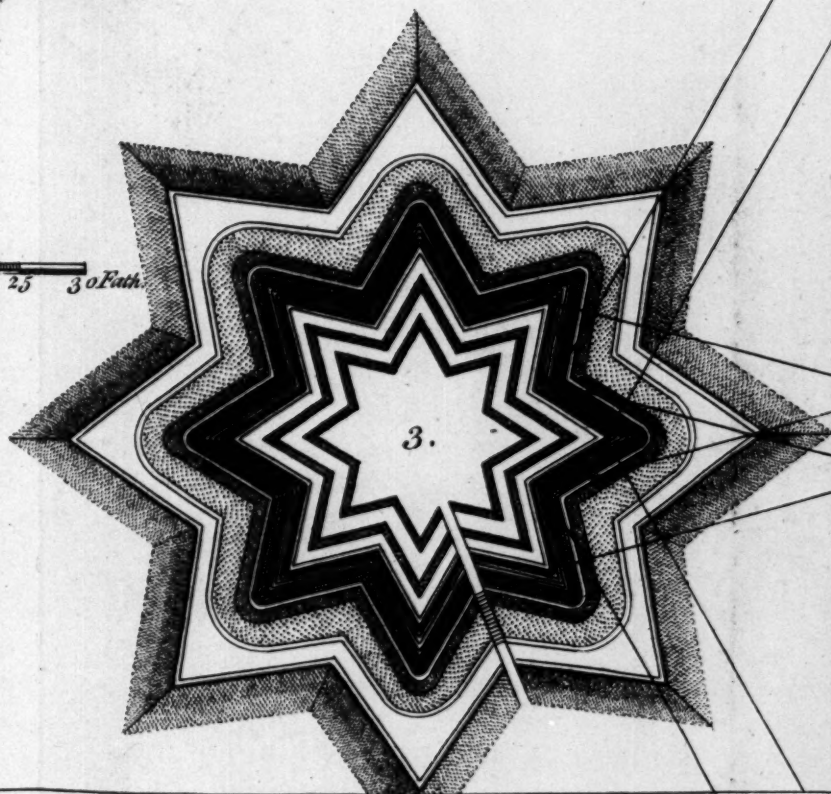
# STAR

# FORTS





5 10 15 20 25 30 Fath.



# ENGINEER

as circumstances sometimes oblige us to it, the following is the best method of fortifying them.

Form an equilateral triangle, and divide the side into three equal parts; lay one of the ends on the prolongation of the side for the capital; draw the line of defence from this point to the extremity of the other side of the triangle; make the gorge equal to the capital, that is, to one third of the side; raise the flank perpendicular according to Figure 1, or rather about 10 degrees more open, as in the plan annexed.

The square is fortified the same way, excepting the angles of the polygon, being more open, in proportion to the number of sides; the line of defence is drawn from the middle of the whole front, that is, from a point taken one third on the curtain, counting from the demi-gorge to the angle of the adjoining half bastion.

I shall not here produce a multiplicity of examples, nor extend to irregular figures, much less to those fortified with whole bastions; it is for the use of young engineers I write; as for those who have made this their principal study, I have perhaps said too much.

V. Forts, open at the gorge, serving generally to cover the heads of bridges, are seldom left to their own defence. For which reason, when the bridge is not made, they are commonly constructed at the



as circumstances sometimes oblige us to it, the following is the best method of fortifying them.

Form an equilateral triangle, and divide the side into three equal parts; lay one of these on the prolongation of the side for the capital; draw the line of defence from this point to the extremity of the other side of the triangle; make the gorge equal to the capital, that is, to one third of the side; raise the flank perpendicular according to *Fritach*, or rather about 10 degrees more open, as in the plan annexed. Plate V.  
Fig. 2.

The square is fortified the same way, excepting the angles of the polygon, being more open, in proportion to the number of sides, the line of defence is drawn from the middle of the whole front, that is, from a point taken one third on the curtain, counting from the demi-gorge to the angle of the adjoining half bastion.

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Fig. 3.

V. Forts, open at the gorge, serving generally to cover the heads of bridges, are seldom left to their own defence.

For which reason, when the bridge is not made, they are commonly constructed at the

the middle of an elbow, which forming a kind of arch, have a better defence than a right line.

If the river is narrow, and the opposite side as high, or higher than that on which the work is, detached flanks are raised, whose effect is the more certain, because the soldier is less afraid of being attacked there.

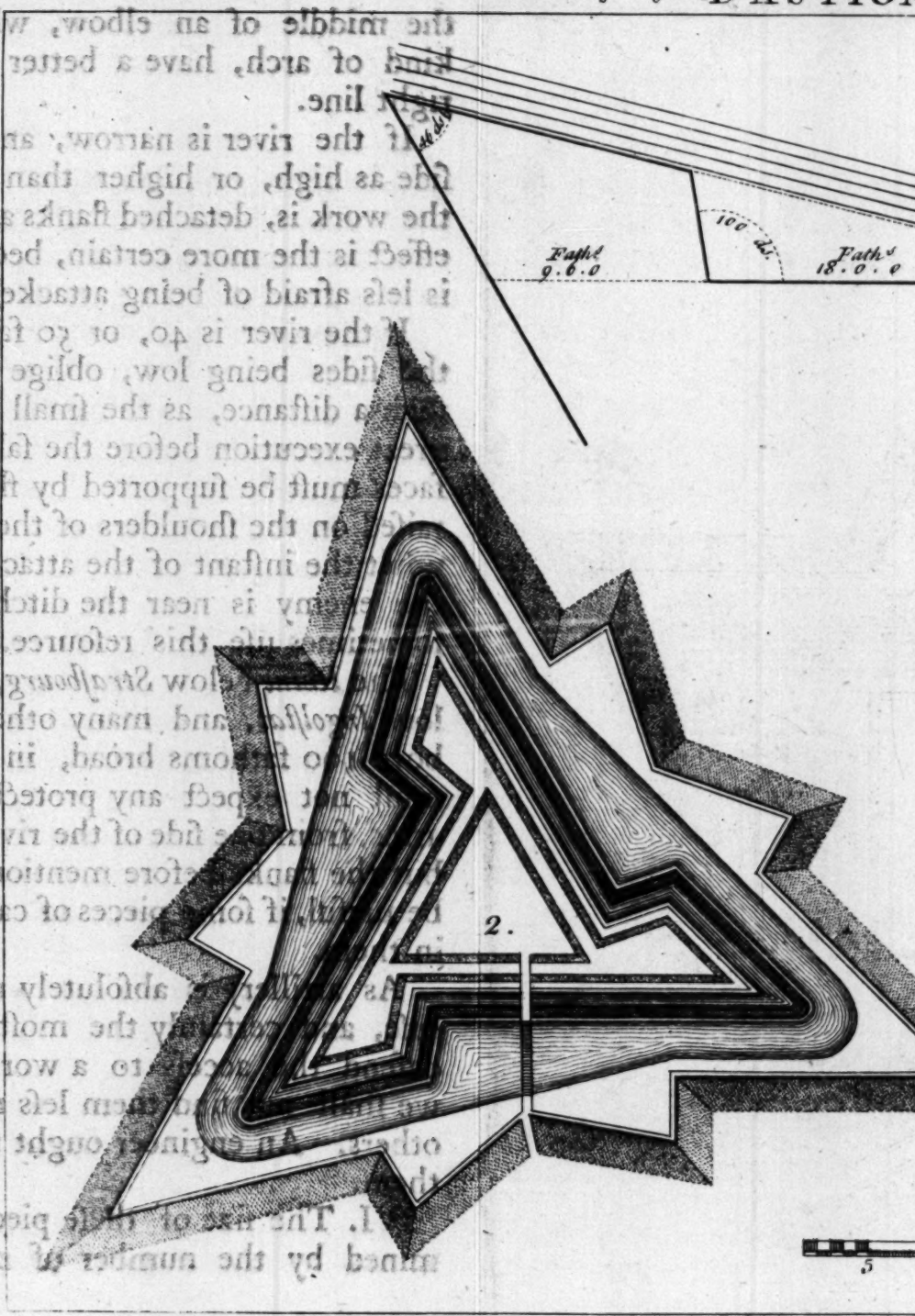
If the river is 40, or 50 fathoms wide, or the sides being low, oblige us to retire to such a distance, as the small arms can do no great execution before the salient angles, the faces must be supported by flanks, which are raised on the shoulders of the work, or flung up at the instant of the attack, that is, when the enemy is near the ditch. We cannot sometimes use this resource.

The *Rhine* below *Straßbourg*, the *Danube* below *Ingolstat*, and many other rivers, are above 100 fathoms broad, in which case, we must not expect any protection from small arms, from one side of the river to the other, but the flanks before mentioned will always be useful, if some pieces of cannon are placed in them.

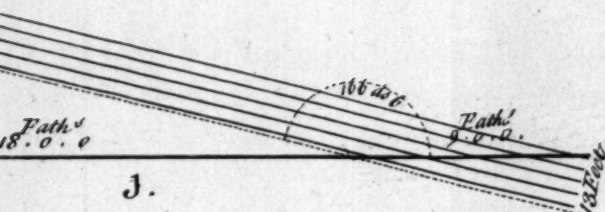
As artillery is absolutely necessary in this case, and certainly the most proper arms to defend the access to a work at a distance, we shall not find them less necessary in the others. An engineer ought then to demand them.

VI. The size of these pieces is not determined by the number of men destined for their

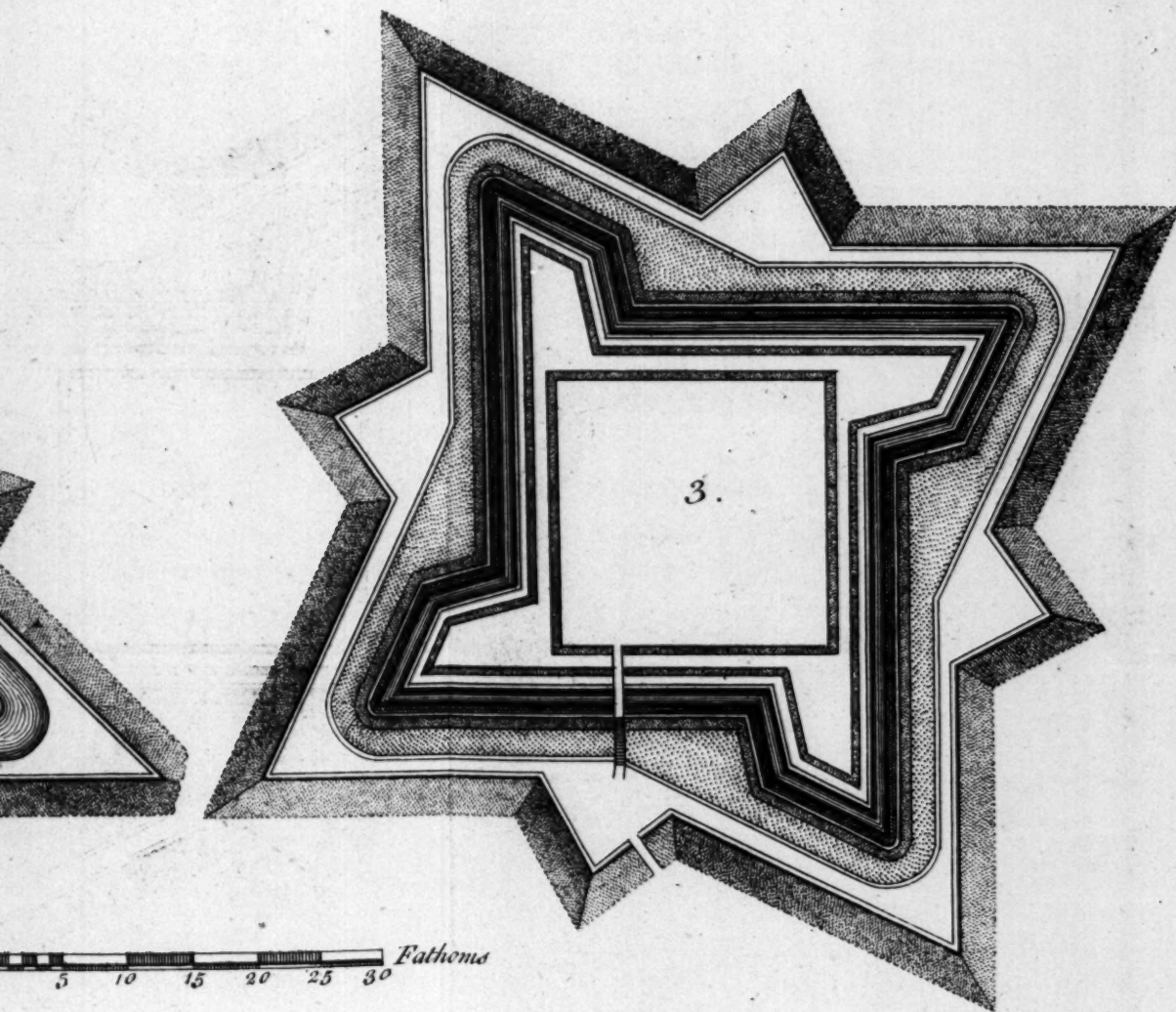
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very broad, in which case, we  
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to a work at a distance.  
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ought then to demand  
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mined by the number of men destined to  
defend it.







3.



5 10 15 20 25 30 Fathoms

# ENGINEER

the ordinary guard, but rather, by that of the troops that are, or may be advanced; because they must be so constituted, that they may file off without confusion, and must also favour their retreat.

The principal circumstances, which can determine their figure, are reduced to three different cases.

1st. When these pieces are near enough to be shanked from the opposite shore, a simple redan may be sufficient: the inclination of the faces is regulated by the nature of the ground, and the parts to be commanded. There is nothing more to be observed, but in proportion as the angle differs from 90 degrees, the capacity of the work diminishes, and the more it is acute, the more direct and nearer its faces are protected.

When the defence is from small arms, at a great distance, flanks must be added to the work itself, observing to scour the faces of these redans, from the other side of the river. These faces will not be too long, when the gorge is no wider than is necessary for an easy communication, the angle of the flank with the branches is about 110 degrees. I executed this at Bonavent, near Kaffan, in 1742, but I had not time to make the intrenchment in the island, which is very low. I suppose it here on a level with the country. When we have no other defence than cannon, all parts of the work, except the next the river,

their ordinary guard, but rather, by that of the troops that are, or may be advanced; because they must be so constructed, that they may file off without confusion, and must also favour their retreat.

The principal circumstances, which can determine their figure, are reduced to three different cases.

1st, When these pieces are near enough to Plate VI. be flanked from the opposite shore, a simple redan may be sufficient: the inclination of the faces is regulated by the nature of the ground, and the parts to be commanded. There is nothing more to be observed, but in proportion as the angle differs from 90 degrees, the capacity of the work diminishes, and the more it is acute, the more direct and nearer its faces are protected,

When the defence is from small arms, at a great distance, flanks must be added to the Plate VII. work itself, observing to scour the faces of these redans, from the other side of the river,

These faces will not be too long, when the gorge is no wider than is necessary for an easy communication, the angle of the flank with the branches is about 110 degrees. I executed this at *Donaustauf*, near *Ratisbon*, in 1742, but I had not time to make the intrenchment in the island, which is very low; I suppose it here on a level with the country.

When we have no other defence than cannon, all parts of the work, except those next the river,



river, being equally exposed, they must be as equally flanked as possible.

Pl. VIII. Here are two works which may serve on  
F.g. 1. such occasions. Form a square; divide each side into four equal parts; take internally one of these parts for the capital; trace the curtain: take one of these parts for the gorge, draw the flank perpendicular to the line of defence.

For the branch, give to the capital and the gorge, one fourth of the side, as in the front, except that the capital be carried externally: draw the line of defence from its extremity to the middle of the whole front; raise a perpendicular from the point of the gorge; prolong it internally half of its length, and from the point of prolongation draw the branch and flank, making an angle of 105 degrees.

As this figure differs in many things, from what has either been executed or published of this kind, I will add some reflections.

The flanks are very large, but the *Terreplein* being of a sufficient extent, and the flanked angle open enough, I see no disadvantage in this: those of the front are perpendicular to the line of defence, not diminishing the faces too much in themselves, have a good defence, as producing a cross fire. The others are more open, to give the fire at the extremity of the branch, the more play.

The inclination of the branches is yet more particular; I draw two advantages from it:

# F I E L D

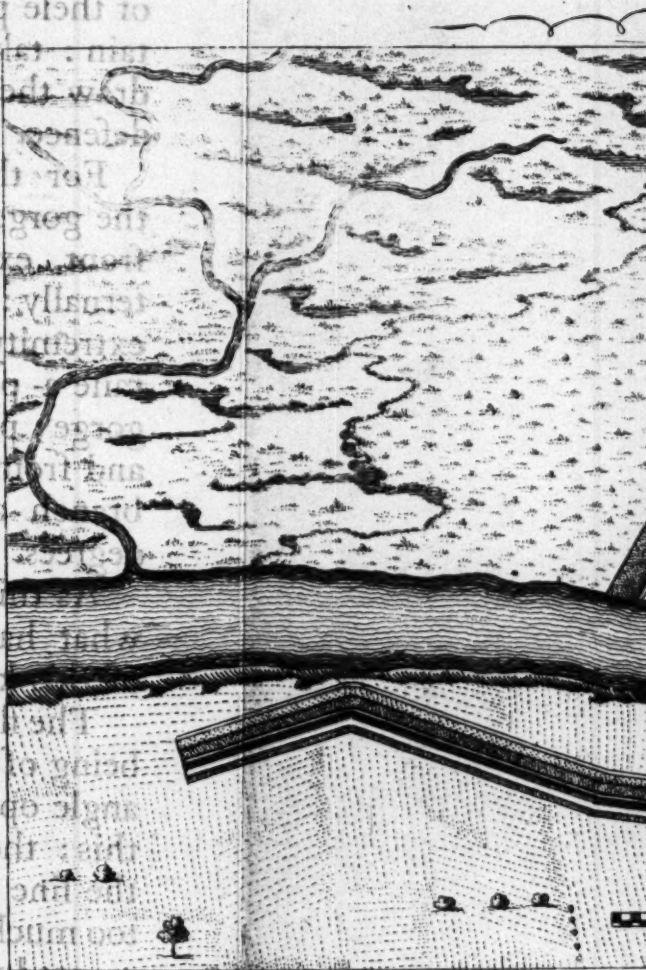
river, being equally exposed, they must be as equally flanked as possible.

III. Here are two works which may serve for such occasions. Form a square; divide each side into four equal parts; take internally one of these parts for the capital; trace the line, take one of these parts for the gorge, draw the flank perpendicular to the line.

For the branch, give to the capital the gorge, one fourth of the side, as in the figure, except that the capital be carried a little further, draw the line of defence from the middle of the whole front perpendicular from the point of the gorge, prolong it internally half of its length, and draw the point of prolongation draw the flank and flank, making an angle of 45°.

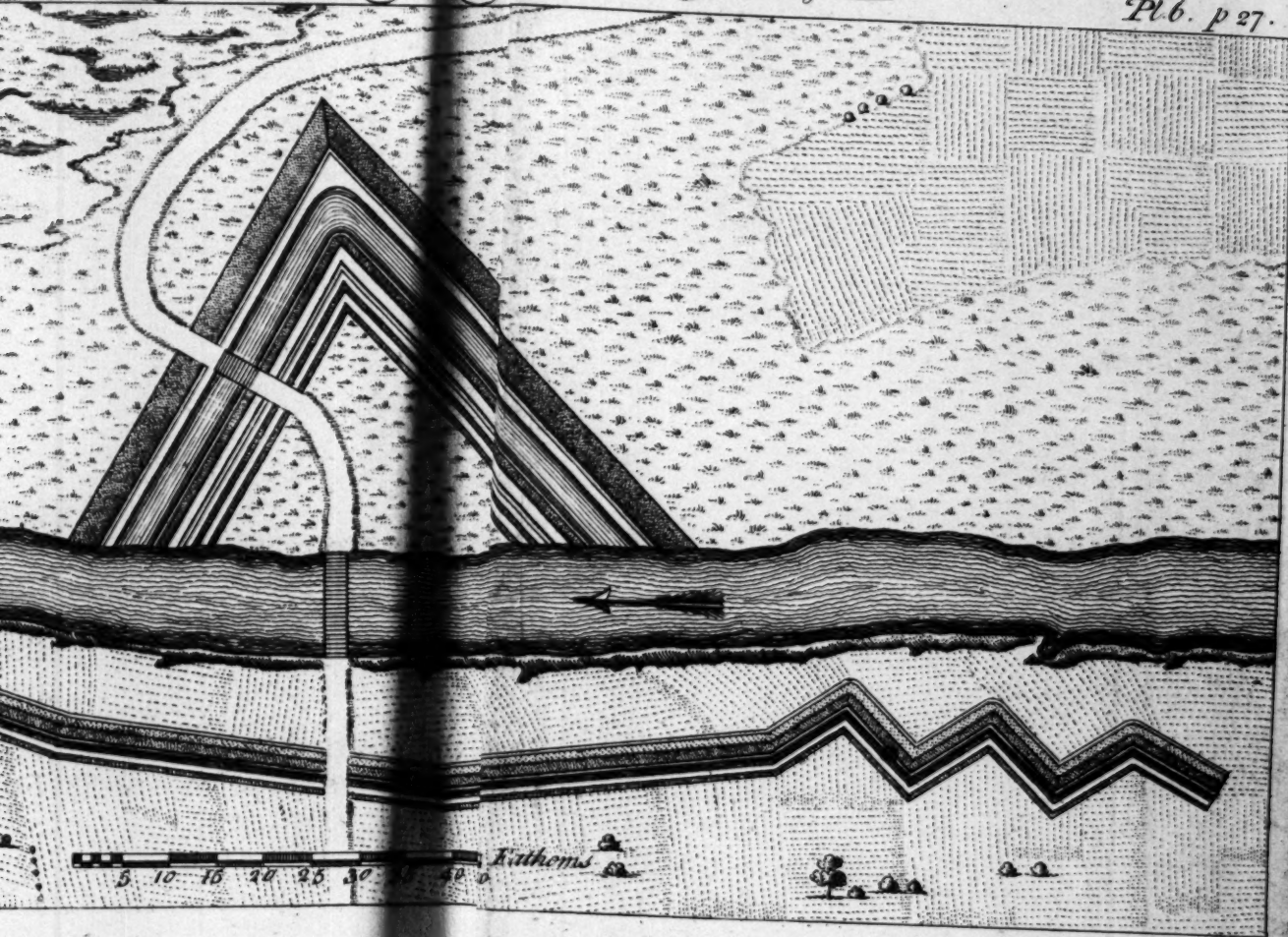
This figure differs in many things from what has either been executed or published. I will add some reflections. The flanks are very large, but the V-shaped angle of a sufficient extent, and the flanks are open enough, I see no disadvantage. Those of the front are perpendicular to the line of defence, not diminishing the strength in themselves, have a good defence, producing a cross fire. The others are more open, to give the fire at the extremity of the branch, the more play.

The inclination of the branches is more particular; I draw two advantages.



BRIDGE HEADS

Pl. 6. p. 27.





Supposing the course of the river in the line, their five falls before one part of the demi-bastion of the gorge; the second, the defence of the second flank, which the face of the gorge, is less oblique. The second flank by this is shortened, but the effect to the manner of estimating its value shall find, that in regard to the gorge, its effect is always the same.

The second figure has its front traced as in the preceding, cut off one sixth of the opening of the gorge; carry two of these sixths to the branch; and from that point forming an angle of 120 degrees, draw the face of the demi-bastion.

This method appears to me preferable to the first, if we are not to be protected from the other side of the river, as the faces are better defended; besides, the demi-bastions are so disposed, which is sufficient.

These different heads of bridges, are to be placed as good works against a sudden onrush, and their use almost momentary, they sometimes serve but for a few days, at most during a campaign.

III. There are some made more durable, as are commonly constructed before the enemy and Fort Lewis, and the enemy before the opening, at the beginning of a war against the emperor, or some other power of the



it : first, supposing the course of the river in a right line, their fire falls before one part of the demi-bastion of the gorge ; the second, that the defence of the second flank, which should graze the faces, is less oblique.

The second flank by this is shortened, but if we advert to the manner of estimating its fire, we shall find, that in regard to the grazing line, its effect is always the same.

The second figure has its front traced as the preceding ; cut off one sixth of the opening of the gorge ; carry two of these sixths on the branch ; and from that point forming an angle of 120 degrees, draw the face of the demi-redan. Pl. VIII.  
Fig. 2.

This method appears to me preferable to the first, if we are not to be protected from the other side of the river, as the branches are better defended : besides, the flanked angles of the demi-bastions are 62 degrees 6 minutes, which is sufficient.

These different heads of bridges, are to be esteemed as good works against a sudden onset only, and their use almost momentary, as they sometimes serve but for a few days, and at most during a campaign.

VII. There are some made more durable, such as are commonly constructed before *Hunningen* and *Fort Louis*, and the enemy before *Philipsbourg*, at the beginning of a war against the emperor, or some other power of the empire.

The

The only one I was ever employed in, was raised in 1733, after the taking of *Fort Keel*, in the island of *Selingen*. I was, as chief of the brigade, charged with its construction, but I did not trace it; it was a horn work, and I do not sufficiently remember its proportions, nor how the branches were defended, to give it here as an example.

We must observe in general, that as these little fortresses are designed to subsist till a peace, and seldom can expect any assistance but from some neighbouring garrison, they must be not only constructed with solidity, but fortified, so as to sustain a regular attack, long enough to be succoured from a considerable distance.

That which covered the bridge of *Philipsbourg*, in 1734, was a horn work, of 45 fathoms in front, with a ravelin, and its branches, which opened and spread from the salient angles, were flanked by demi-bastions; we frequently find figures of this kind on the *Rhine*: if either of the constructions I have given should be used in the like case, the front must either be more than 60 fathoms, or the faces longer, without which the ravelin will not be sufficiently defended.

As these works are commonly planned and executed more at leisure than the others, the whole art of fortifying places may be here practised: in 1742, I projected the half of a square for the bridge of *Deckendorf*, the *Danube* forming the diagonal; but an epidemic disorder

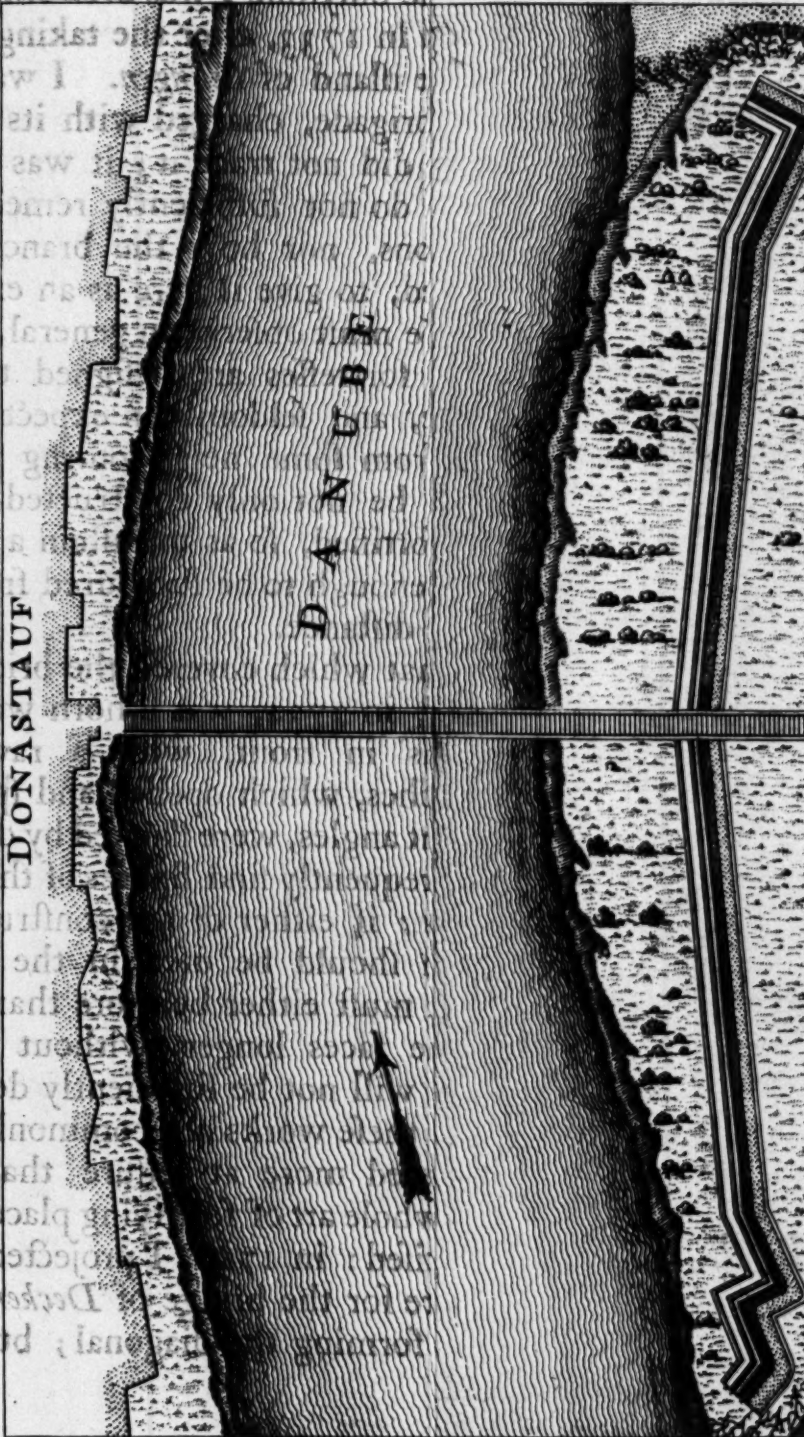


# FIELD

is only one I was ever employed in. I was engaged in the taking of the island of ... I was, as ... with its ... was a ... of ... was a ... of ... was an ... of ... that ... to ... any ... y ... with ... a regular ... from a ... of ... of ... and ... from the ... - ... this kind of ... I have ... the like ... do ... which the ... defended. ... planned and ... than the others ... places may be ... the half of ... the ... but an ...

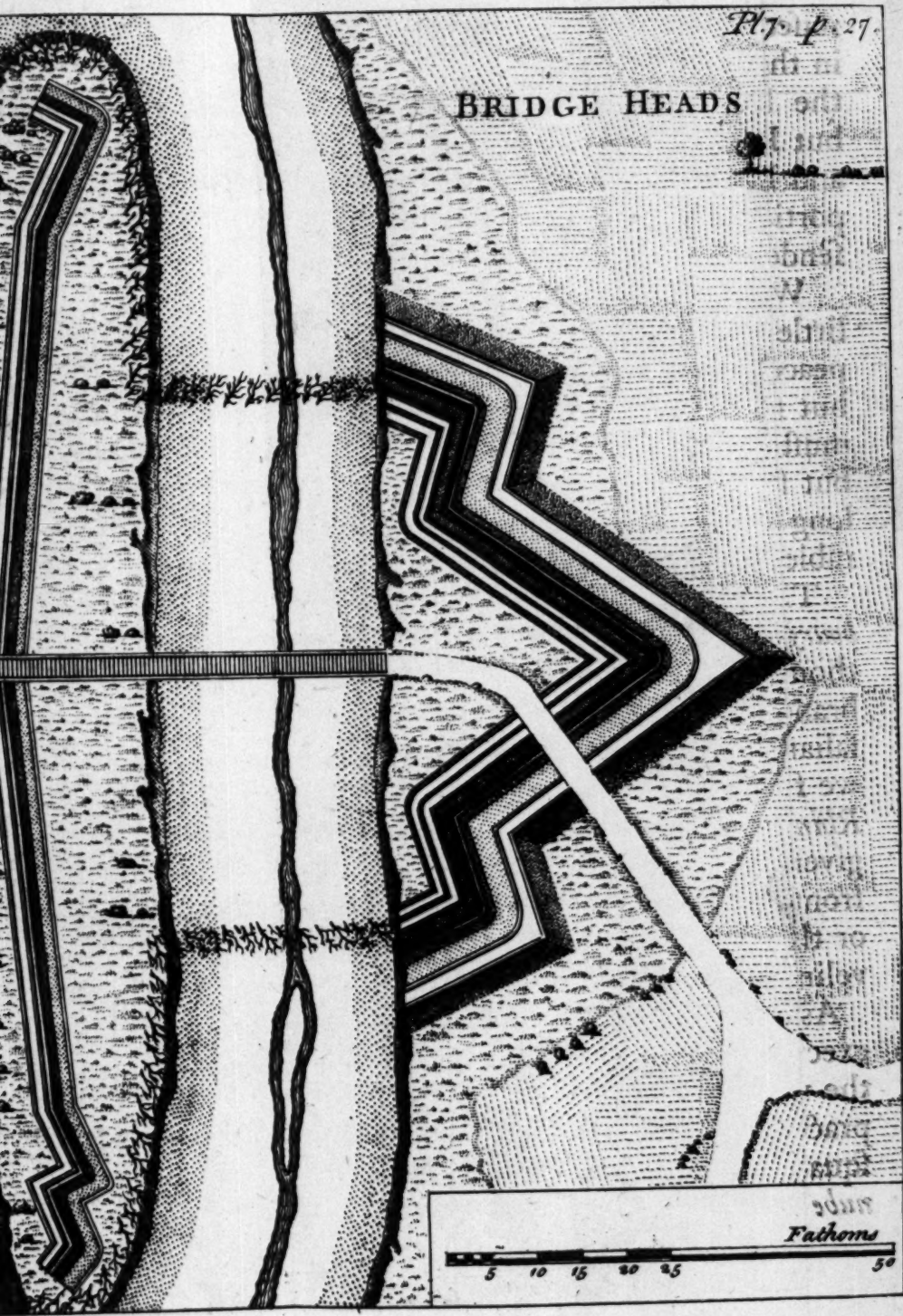
DONASTAUF

DANUBE



Pl. 7. p. 27.

# BRIDGE HEADS



# ENCIPHER

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The front of the polygon was ...  
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The work which covered the head of the ...  
 ...the ...  
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 ...the ...  
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VIII. A work of what kind however is ...  
 ...the ...  
 ...the ...  
 ...the ...  
 ...the ...



disorder raging at that time amongst the soldiers, were left scarcely sufficient for more indispensable Service. This figure is of great extent, and encloses but little ground; circumstances, which joined to some others, determined me to prefer one to it, which I shall mention hereafter.

This half square was constructed according to *M. de Vauban's* Method, excepting, that having no reason to fear the line of defence would be too long, I shortened the faces, to lengthen the flanks, which I made, for the reasons already mentioned, perpendicular to that line.

The front of the polygon was 60 fathoms, which is the least this figure can have, even for a field fortification. They will be acknowledged right, if we reflect on the smallness of the flanks and *Terreplein*.

The work which covered the head of the bridge at *Philipsbourg*, after taking that place, made by the *Dauphin* in 1688, was larger, but similar to this.

VIII. A work, of what kind soever, is only fortified, in proportion as it has flanks, and in the different cases mentioned, we may not always be able to give them as much extent as necessary, without too much diminishing the figure: the proximity of a morass, a rivulet, a low ground, the necessity of occupying eminences, especially for the salient angles, without which, the branches, and perhaps

perhaps even the *Terreplein*, are exposed, are obstacles often very difficult to surmount.

This reflection gave birth to an expedient, which I had formerly proposed to the court for a different use; which is, to equip two boats, with two pieces of cannon in each, and as many small arms as shall be judged convenient; when boats cannot be found large enough, many may be fastened together to form pontoons.

The movement of this machine is the same as our common ferry-boat, that is, by making a cable pass on two turning cylinders, or rings fastened to its side, one end of which is fastened to the bridge, and the other to an anchor, cast at some distance in the river.

If the current is not very strong, the cylinders, or rings, are fastened one on each side, so as to give the side of the boat its proper direction; but, if it be ever so little rapid, the boat must have its head to the current, or it will be in danger of being drove on shore. A parapet of madriers, or double planks, may be made, if judged necessary.

If the attac is made with cannon, these moveable flanks are brought behind the gorge of the work, and do not appear till the enemy shall be near enough, that they may have their full effect. The surprize, which the unexpected sight of those floating batteries, will produce in the assailants, is another advantage, and if they do not put them into disorder, they will probably slacken their ardor.

I suppose

I suppose here, the river is not so buried in its banks, but that we can command the country from the platform of the boats. This scheme struck me at *Deckendorf*; it is practicable on the *Danube*, in almost every part I have seen; the following year arriving at *Wormes*, I found it done on the *Rhine*, but in a less perfect manner, for the boats were fixed.

The great defence, and above all the surprise, were the only objects I proposed at *Deckendorf*, where, by the uniformity of the ground, I could have given what figure I pleased to the work: but I believe this expedient is not confined to circumstances.

IX. We frequently employ these vessels in places for other uses; they may also be of service in the field, but as this concerns the engineer only, as he may be obliged to defend himself against them, I shall content myself with some examples to support what I have advanced.

I saw at *St. Omer*, in 1710, or 1711, boats armed with one cannon, whose carriage turned on a pivot, as occasion required; they had at the same time galliots on the inundation of *Condé*, and some were built in 1735 at *Straßbourg*. It is well known, that when the *Imperialists* were at war with the *Turks*, they had whole fleets of \* *Saïques* towards *Belgrade*.

**D** The

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\* *Saick* or *Saïque* is a *Turkish* vessel, with a bowsprit, small mizen, and a main-mast, which, with its maintop-mast,



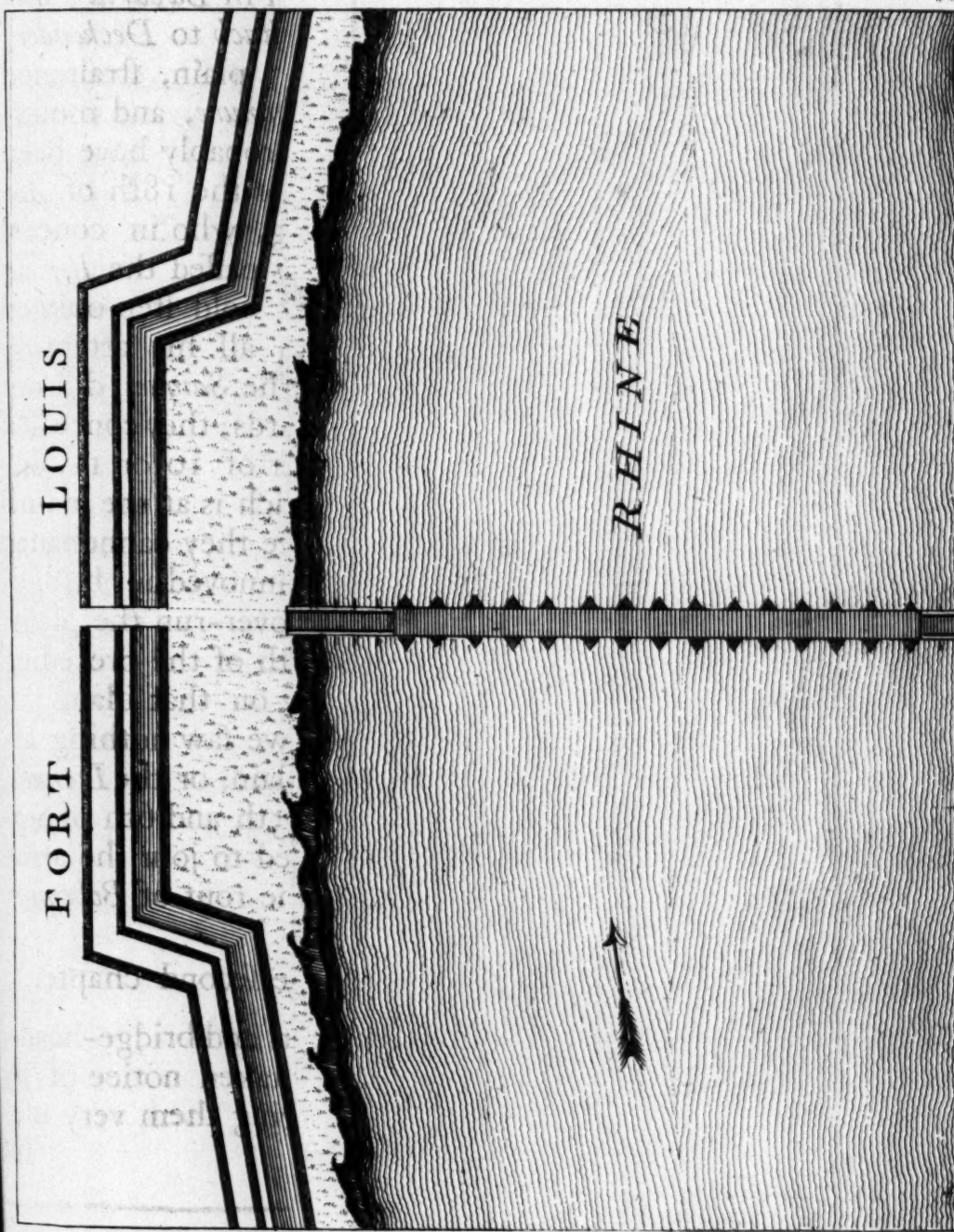
The *Austrians* had them in *Bavaria*; and as the rout from *Nieder-Altach* to *Deckendorf* is cross an even and open plain, straitened in some places by the *Danube*, and mountains, our army would probably have been disturbed in their march of the 18th of *August* 1742, if count *Thoring*, who in concert with count *Saxe*, suddenly passed the *Iser* at *Pladling*, had not by that bold step obliged M. *Khevenbullen*, to turn all his attention and forces that way. The *Saiques* did not appear till two days afterwards; they concealed themselves, to the number of 10 or 12, under cover of an island, which is at the mouth of that river, from whence they cannonaded our guards of cavalry, and annoyed our bridge; the hussars and pandours over-run the plain: I had proposed on the 30th of the preceding month, to raise a battery on that island: it was at length done, and we saw nothing afterwards, either on the plain, or the *Danube*, to the night between the 5th and 6th of *September*, when we decamped to join the army of M. de *Maillebois*, by the rout of *Bohemia*.

#### OBSERVATIONS on the second chapter.

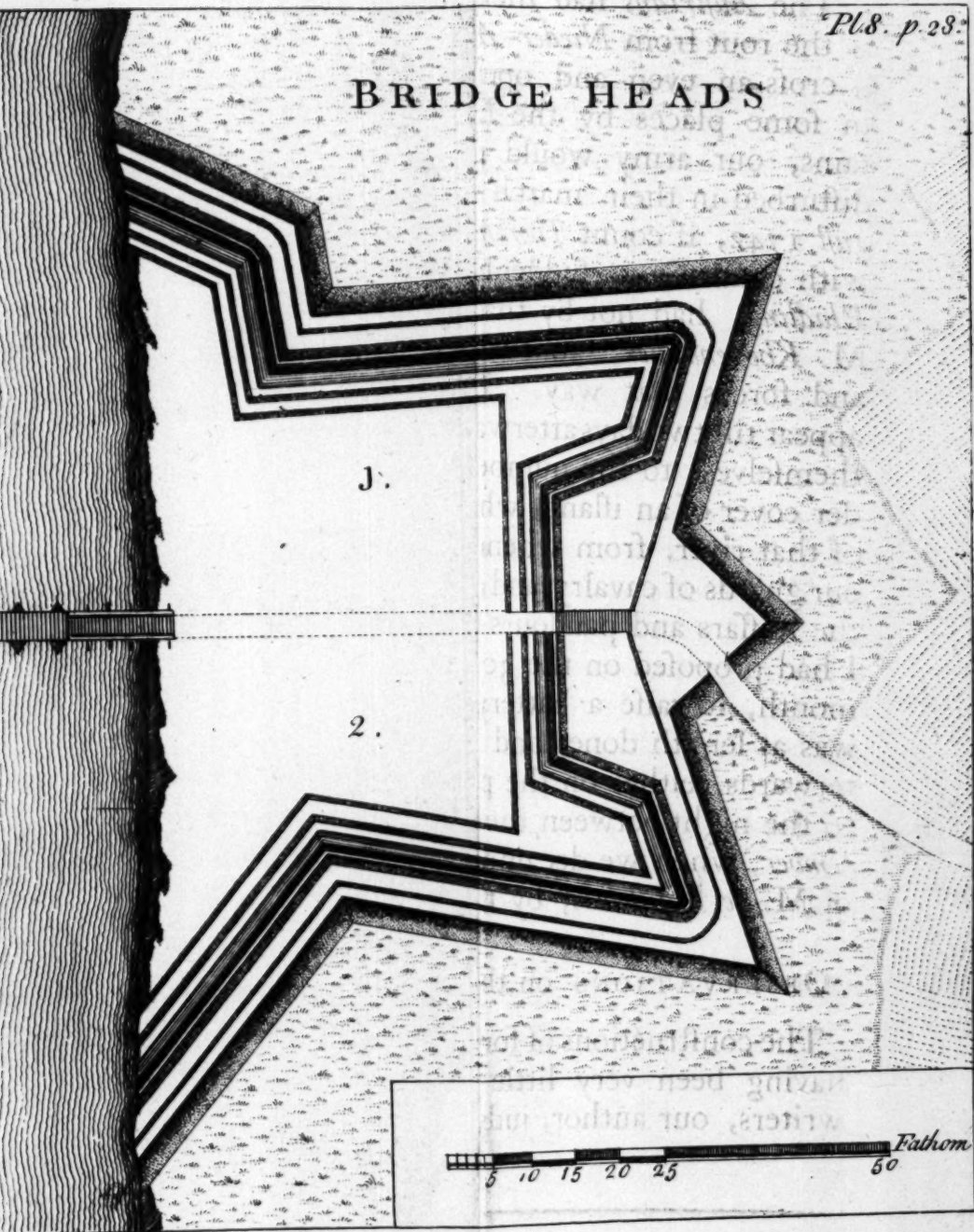
The constructions of forts and bridge-heads, having been very little taken notice of by writers, our author, judging them very useful

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mast, is supported at an extraordinary heighth, by stays from the topmast, to the bowsprit and sides.



# BRIDGE HEADS





and absolutely necessary, treats of them  
and as his method is something par-  
ticular, and supposes the reader to be ac-  
quainted with the common practice, which  
not being always the case, we thought an  
explanation would not be altogether useless,  
especially to beginners.

At the bottom, the four with points at  
their angles, constantly called for, are  
the most simple, that have some defects,  
they are very oblique; they are made from  
four to eight points; the square one is con-  
sidered, by making the perpendicular  $FE$  to  
the middle of the side  $AD$ , equal to one eighth  
part of that side; but in the pentagon the  
perpendicular is one sixth part of the side;  
in the hexagon, an equilateral triangle is made  
upon each of the sides.

The octagon may be traced in the same  
manner as the hexagon; that is, by making  
an equilateral triangle upon each side; but as  
this construction is somewhat difficult in the  
practice; the author gives the following one;  
and the square one  $ABCD$  as before; divide  
each of the sides  $AE$ ,  $DE$ , into three equal  
parts, and make upon the distance between  
the points of division  $G$ ,  $H$ , next to the point  
 $E$ , an equilateral triangle, which forms the  
angle  $GLH$ . As to the four feet of seven  
points, it is never used, because it is too dif-  
ficult to trace on the ground.

As the defence of these forts is so very  
oblique, especially in a square, and the con-  
struction

ful and absolutely necessary, treats of them here: and as his method is something particular, and supposes the reader to be acquainted with the common practice, which not being always the case, we thought an explanation would not be altogether useless, especially to beginners.

After the redouts, the forts with points or salient angles, commonly called *star forts*, are the most simple, that have some defence, though very oblique; they are made from four to eight points: the square one is constructed, by making the perpendicular FE to the middle of the side AD, equal to one eighth part of that side; but in the pentagon this perpendicular is one sixth part of the side. In the exagon, an equilateral triangle is made upon each of the sides. Plate A.  
Fig. 2.

The octagon may be traced in the same manner as the exagon; that is, by making an equilateral triangle upon each side: but as this construction is somewhat difficult in the practice; the author gives the following one: find the square one ABCD as before; divide each of the sides AE, DE, into three equal parts, and make upon the distance between the points of division G, H, next to the point E, an equilateral triangle, which forms the angle GLH. As to the *star fort* of seven points, it is never used, because it is too difficult to trace on the ground. Fig. 2.

As the defence of these forts is so very oblique, especially in a square, and the con-

structions of the others require too much time and workmanship; they appear to me scarce worth while to be made, excepting on some very particular occasions. The forts next in rank are those with half bastions; which are not much better than the former, as having their faces very little defended; the construction of the triangular one is; take the part AD of an equilateral triangle ABC, equal to one fourth of the side AC, draw BD, in which take DE equal to DA, and draw the flank EF at right angles to BD; then AF will be the face of the half bastion, and EB the curtain.

Plate A.  
Fig. 3.

Instead of half bastions, I would make whole ones, placed in the middle of the side, as in this figure; where the gorge DC and the capital EF are each one fifth part of the side AB; the flanks are perpendicular to AB, and equal to one tenth part of the side, or half the gorge. By this construction, the salient angle F is a right one, which is preferable to any other; and there is no part but what is seen and defended by some other; the second flank which defends the face is four fifth of half the side BE; and therefore the direct flank BL is about two fifths of BE nearly. Besides, as this figure is more regular than the former, it will contain a greater space within the same inclosure.

Fig. 4.

The construction of the square fort is; produce the side DC to E, so as CE be equal to one third of DC; divide the side BC into three equal parts in G, H, draw the line of defence

Fig. 5.



defence EH and the flank GF perpendicular to the side BC. Although the faces of this fort are defended by a second flank equal to half the side of the square, yet on account of the great difficulty of firing so obliquely over a parapet of 8 or 10 feet thick; the following fort with whole bastions is preferable, and is also more practised. Make the perpendicular CD to the middle of AB, equal to one tenth of the exterior side, and the faces AF, BG equal to one fourth of that side: the flanks are drawn at right angles to the lines of defence.

Fig. 6.

The bridge-heads are made of various figures and sizes, sometimes like a redan or ravelin, with or without flanks, sometimes like a horn or crown work, according to the situation of the ground, or to the importance of its defence. Their construction depends on various considerations; when the river is so narrow, that the work may be flanked from the other side, a single redan is sufficient, but when the river is so broad, as that the salient angle cannot be well defended cross the river, flanks are made to the redan: but if the river is a 100 fathoms or more across; half a square is made, whose diagonal is the river side: but when it is from 3 to 500 fathoms broad, a horn or crown work is then to be made.

A river may be strait or crooked; if it be strait, the bridge is made before the middle of the front of the army; and sometimes two at equal distances from the center and wings;

D 3

supposing

supposing the ground to be equally favourable, otherwise they are placed where it is most convenient.

Fig. 7.

If the river be crooked, the inward bend is to be chosen; for suppose *a, b, c*, to be its course, if the bridge is made at *b*; the enemy cannot see, or flank it from any part on the other side; the batteries placed at *K* and *L* flank and defend not only the faces of the head *P*, but likewise all the part *D, E*, about it; by which the troops may march out, and draw up in order of battle, without the enemy having it in his power to disturb them, but at a great distance. On the other hand, if the bridge was made at the outward bend as at *a* or *c*; it would be enfiladed from both sides, the head could not be defended but from a great distance, and very obliquely; and the troops could not form before the work, without danger of being charged immediately by the enemy. Therefore such a situation should be avoided if possible.

Fig. 8.

When the river is narrow, a triangle *ABC* is made upon the bank *AC* of the river, so as the salient angle *B*, may not exceed a right angle, nor be less than 60 degrees; which may be done at sight, without the help of an instrument: as to the length of the sides *AB, BC*, it depends on the number of men to defend it. For instance, supposing three rows at three feet distance from one another; then six times the length of one face expressed in yards, will be the length required. If there-  
fore.

fore each face is 50 or a 100 yards; it would require 300 or 600 men to defend it: besides a body to support them, and to supply the places of those that are killed and wounded.

If such a work requires flanks, take AE equal to one fourth of AB, erect the flank EF perpendicular to AB, and equal to AE, draw the line of defence BF, which, when produced, determines the face FD.

But when the river is so large, that no defence can be expected from the other side: construct half a square ABC, in the same manner as in the sixth figure, and so as the diagonal AC be the river side. Fig. 9.

When the bridge is to remain during the course of a war, such as that built at *Fort Louis* upon the *Rhine*; it requires a larger work than the preceding ones: for which reason, a kind of horn or crown-work is to be made, or such as is represented in this figure, which is thus constructed. Let ABCD Fig. 10. be a square, take BE, CF, each equal to a fourth part of the side, draw EF, in which take the parts EG, HF, each equal to one fourth also, or to BE, and CF, draw the lines of defence BH, CG, and the flanks GL, HK, perpendicular to CG, BH the lines of defence.

The branch PROC is constructed, by setting off from the point D, the part Da upon DC, and DP upon AD produced, each equal to one fourth part of the side AD; take aQ

D 4

equal

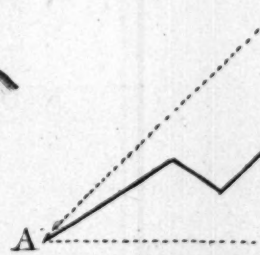
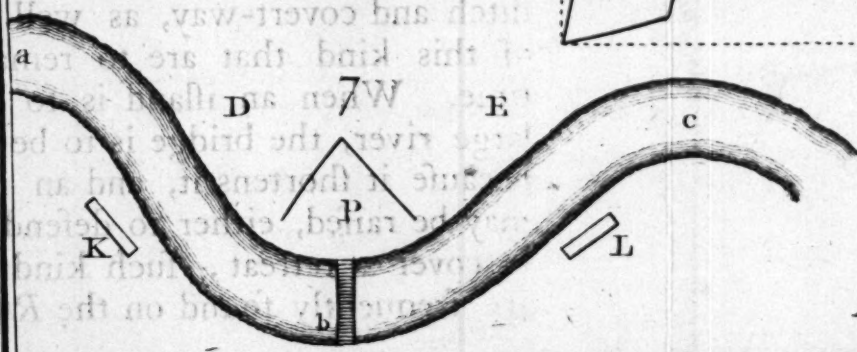
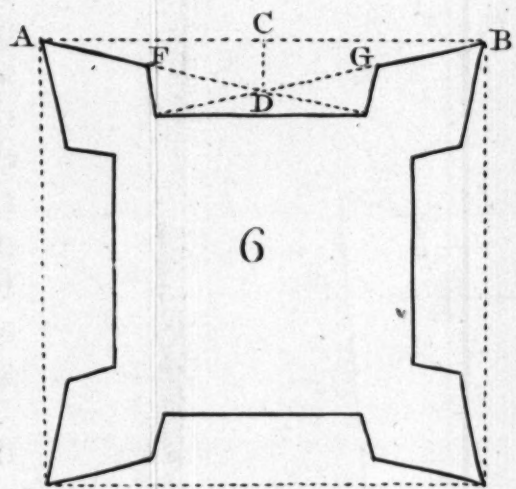
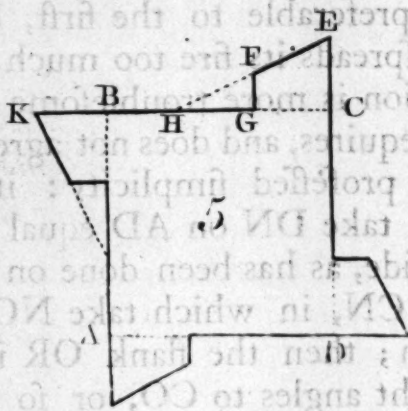
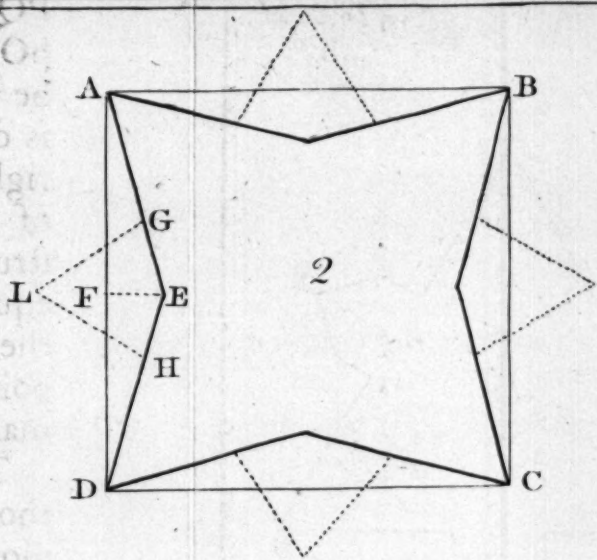
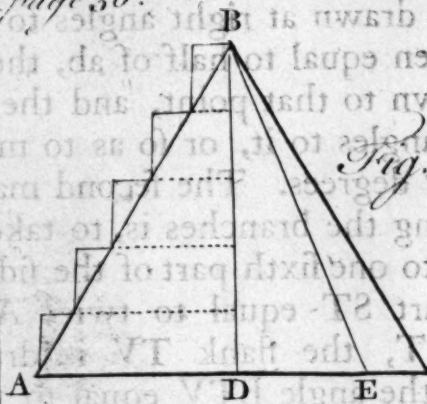


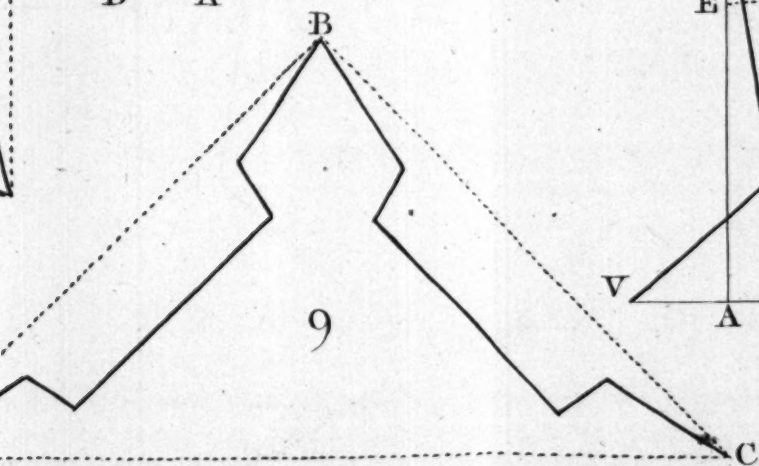
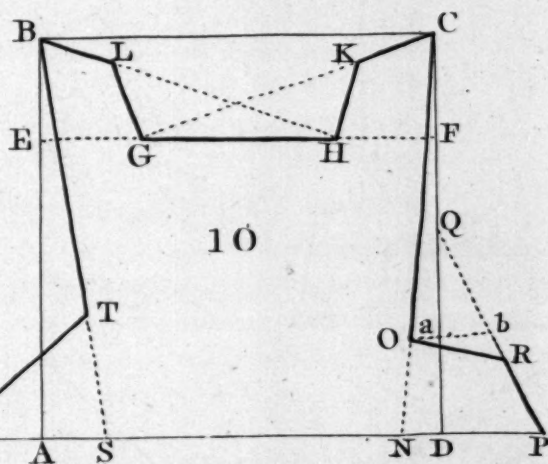
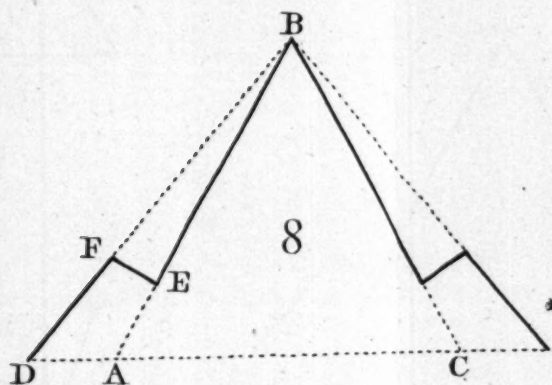
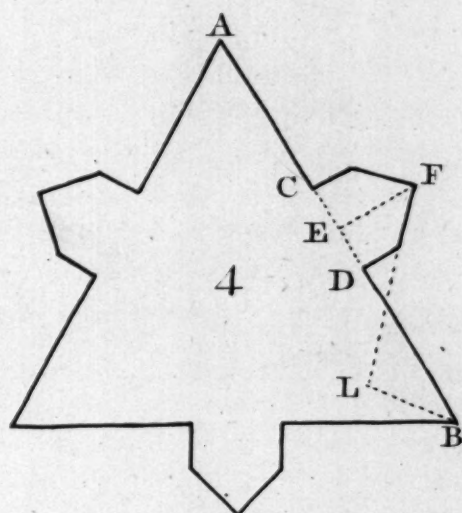
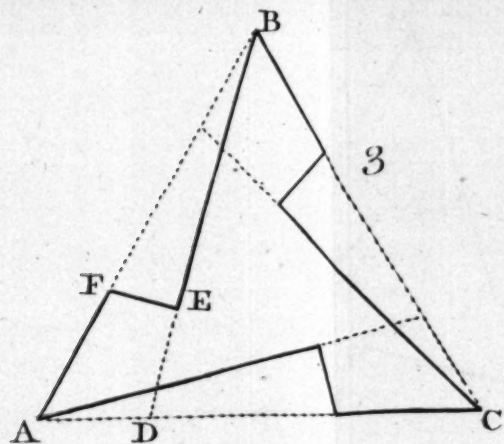
equal to Da, and draw the line of defence PQ: then if through the point a, the line bO be drawn at right angles to DC, and aO be taken equal to half of ab, the curtain CO is drawn to that point, and the flank OR at right angles to it, or so as to make an angle of 105 degrees. The second manner of constructing the branches is, to take AS on AD, equal to one sixth part of the side, and in BS, the part ST equal to twice AS; from the point T, the flank TV is drawn so as to make the angle BTV equal to 120 degrees.

This second method is esteemed by the author preferable to the first, but in my opinion spreads its fire too much: the first construction is more troublesome than the subject requires, and does not agree with the authors professed simplicity: it may be done thus; take DN on AD equal to one sixth of that side, as has been done on the other side, draw CN, in which take NO equal to one fourth; then the flank OR is drawn either at right angles to CO, or so as to make an angle of 100 degrees; and equal to NO.

This front must be covered by a ravelin, ditch and covert-way, as well as all works of this kind that are to remain for some time. When an island is to be found in a large river, the bridge is to be made there; because it shortens it, and an intrenchment may be raised, either to defend the head, or to cover a retreat; such kind of situations are frequently found on the *Rhine* and *Danube*,

Fig. 1.







and they are not neglected by the  
 forward on the forward when they cross these

## CHAPTER THE THIRD.

I. Examples of the manner of fortifying a camp.  
 II. A church. III. An old castle. IV.  
 A country-house. V. Attack of a country-house.  
 VI. Various instructions on the different subjects of this chapter.

**B**esides posts, which require the works  
 we have spoken of in the preceding chap-  
 ter, there are others which do not less demand  
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 tified according to the time, numbers, and  
 means we are masters of, and the use we  
 would make of them: I shall explain myself  
 better by examples.

The first of October 1742, having set out  
 with twenty-one engineers, from the camp  
 of Brainerd, to go to attack the next day  
 three leagues below Tirkburn, we found a  
 considerable body of militia, waiting for us  
 at the end of a wood, and who at first kept  
 at a distance, seemingly the better to recon-  
 noitre us.

Our escort consisted of thirty-three men of  
 the independent company of Lincolns, for the  
 most part badly provided with pistols, and  
 baggage liable to put us into confusion.

nube, and they are not neglected by the Germans or the French when they cross these rivers.

### CHAPTER THE THIRD.

I. *Examples of the manner of fortifying a church-yard.* II. *A church.* III. *An old castle.* IV. *A country-house.* V. *Attack of a country-house.* VI. *Various instructions on the different subjects of this chapter.*

I. **B**ESIDES posts, which require the works we have spoken of in the preceding chapters, there are others which do not less demand our attention and judgment. They are fortified according to the time, numbers, and means we are masters of, and the use we would make of them: I shall explain myself better by examples.

The first of *October* 1742, having set out with twenty-one engineers, from the camp of *Bramerkof*, to go to *Amberg* the next day, three leagues below *Tirschenreit*, we found a considerable body of hussars, waiting for us at the end of a wood, and who at first kept at a distance, seemingly the better to reconnoitre us.

Our escort consisted of thirty-three men of the independent company of *Limont*, for the most part badly provided with pistols, and our baggage liable to put us into confusion, yet

yet being determined to go forward, we passed thro' the village of *Psaffernreit* without stopping.

Scarcely were we got out, when the hussars, who had taken a tour round it, briskly attacked us with pistol and carabine; this did not prevent us continuing our journey with a slow pace, and in good order, 'till we were opposite to *Miteldorf*.

This skirmish lasted above an hour; two engineers were taken, one of whom was wounded, another was also wounded, with four domestics. The enemy did not suffer less, but they were not discouraged, their number encreasing every moment; the more we advanced, the less hopes we had of assistance: these circumstances determined us to throw ourselves into the village.

We soon saw that this was no asylum for us; we found neither church nor walls to enclose us; this place consists of a dozen houses of wood, or deal planks laid on one another, and pinned at the corners, according to the custom of that country. We had all the dreadful effects of fire to fear, a kind of attack very inhuman, yet customary with the people we had to deal with, and who were encouraged by a considerable sum, which they found on one of the prisoners; this made us certain, that if they quitted us, it was only to return in a little time with a greater body.

In



In this dilemma, we reconnoitred and reached *Vurz*, a village, in which we perceived a steeple, and which was about the eighth part of a league on our right.

Having carefully examined the avenues, and barricaded them with trees, baggage waggons, carts, &c. from each of which we took a wheel or two : we raised a banquet along the wall of the church-yard, where we fixed with our baggage; making use of the church, in the door of which we had cut loop-holes, as a citadel, and the steeple as a redout, which must be our last shift.

Two stone houses almost touched our bounds, but being built on very low ground, the height of their walls did not exceed that which served us as a parapet. We would not open these walls, and yet we must have a communication with those houses; the possessing them was absolutely necessary, as well to avoid being overlooked, as to give us some flanks. We therefore judged it best to construct our communication in form of a bridge, from the top of the intrenchment into the roof, and having barricaded the doors and windows in the lower floor, we here fixed some guards.

I thought the recital of what we did upon this occasion, might serve as an example how to act upon a like occasion: altho' our precautions were prudent, they happened to be useless; for the hussars, being tired of waiting for us on the road, went off in order to return the  
next

next day in a greater body; but in the mean time, after we wrote every where for succour, and could get no more than fifty men of the same company, and who had orders to go no farther; we retired, and got to *Tirschenreit*, before they returned.

II. The church of *Vurz* was doubtless a more secure post than the church-yard; but as we would not abandon our horses, nor put them into the church, this retreat required works which we had neither time nor means to execute.

When a church is to be defended, the doors must be covered with breast-works, of thick pallisades, joined or lined with planks: the loop-holes must be six feet high at least, that the enemy may not reap any advantage by them: the earth of a little ditch which surrounds it, serves to form the banquet.

The doors and walls must also have loop-holes, or, if the walls be too thick, make them in the windows; this supposes a scaffolding, which should run round the whole building, to facilitate a communication from one part to another.

If the church be in form of a cross without, it in part flanks itself; if not, the vestry at least flanks one of the long sides, and the breast-work should be so disposed as to produce the same effect on the other.

There remains then only the rear of the choir, absolutely defenceless, this is remedied  
by

by piercing a second row of loop-holes, low enough to discover the adjacent parts before it; or else project from the windows and the roof, (and as high as possible for fear of fire) some little *Machicoulises* of wood.

If the steeple does not afford the same advantage as the vestry, it may serve at least to see what passes at a distance, and as a redout to capitulate in, in case succours do not arrive in time. The church of *Berg*, a village in the neighbourhood of *Lauterbourg*, was intrenched in this manner during part of the war, terminated by the treaty of *Radstat*.

III. Castles, and large well-built country-houses, are to be preferred to churches, because greater advantages are commonly derived from them.

I shall explain myself by what I have seen; this manner of instructing, I am sensible, flatters an author, but rouses the reader's attention, who generally has more regard for the recital of facts, than to simple precepts.

The first castle I had orders to reconnoitre was that of *Natterburg*, half a league from *Deckendorf*, on the *Danube*.

It was the ruin of a considerable fortress Plate IX. for a private man: it possessed the whole summit of a very steep hill, which was long and sloping, and almost every where of an equal breadth: the buildings were in ruins, but the surrounding walls were solid and well preserved.

In



In the plan annexed, no flank can be seen in the surrounding wall, because in my passage through I discovered none, perhaps, by not being able to penetrate into some places encumbered and obstructed by the falling of the floors and roofs; but the steepness of the hill on three sides, and the other, that is the extremity of the *Esplanade* being of little extent, and furnished with a ditch, supplied this defect.

One very material circumstance was, that the walls of the fore-court were about 15 feet high, and those of the castle more than 30, and were not made with loop-holes.

This little fortress, as may be seen, cannot be attacked but on the front of the *Esplanade*, which the first builders had in view, at least we may judge so, by the different walls, which must be broke through, or got over, on that side, before it can be taken.

It will therefore be sufficient, to erect two scaffolds, at the two angles of the rear of the castle, so high as to discover what passes over the surrounding wall, and so disposed as to flank the three sides, if necessary.

In regard to the principal walls of the front, *viz.* Those of the castle, the *Faus-braye*, and the fore-court, must have banquetts, platforms, and loop-holes, likewise holes made in the most convenient places, large enough to serve for embrasures for some small pieces of cannon.

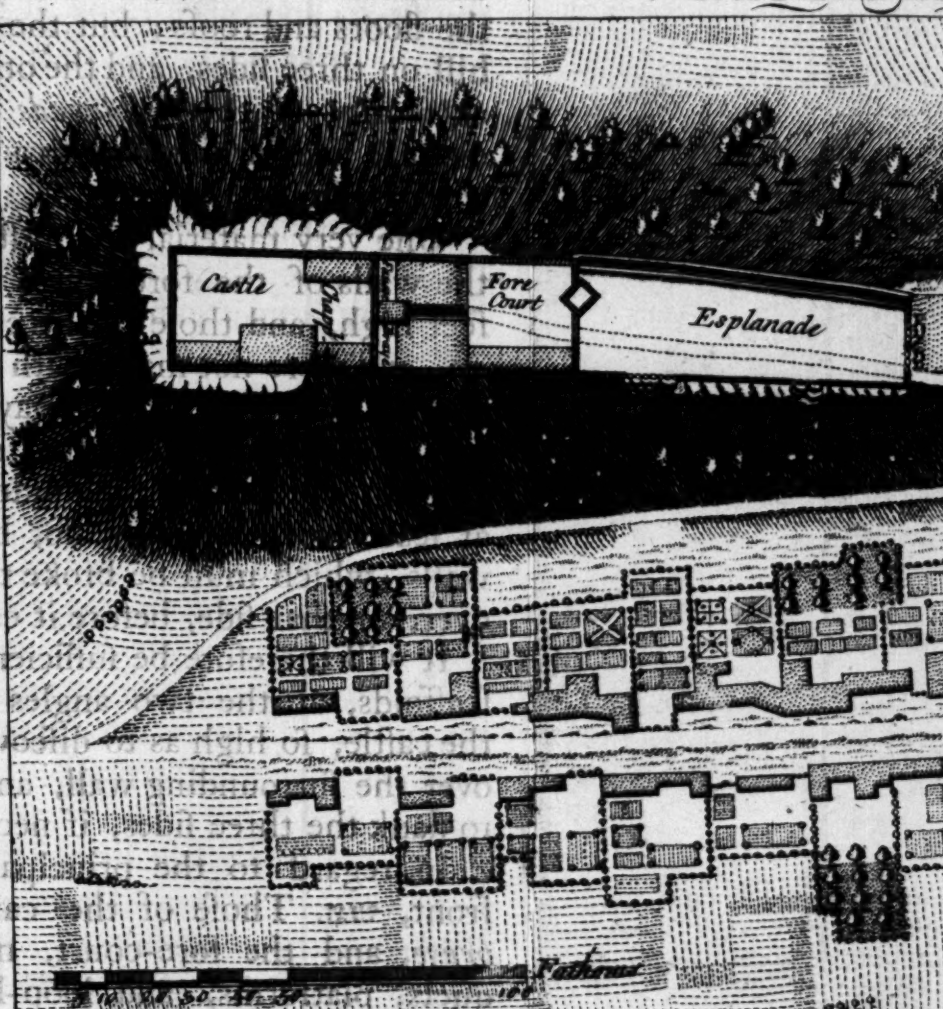
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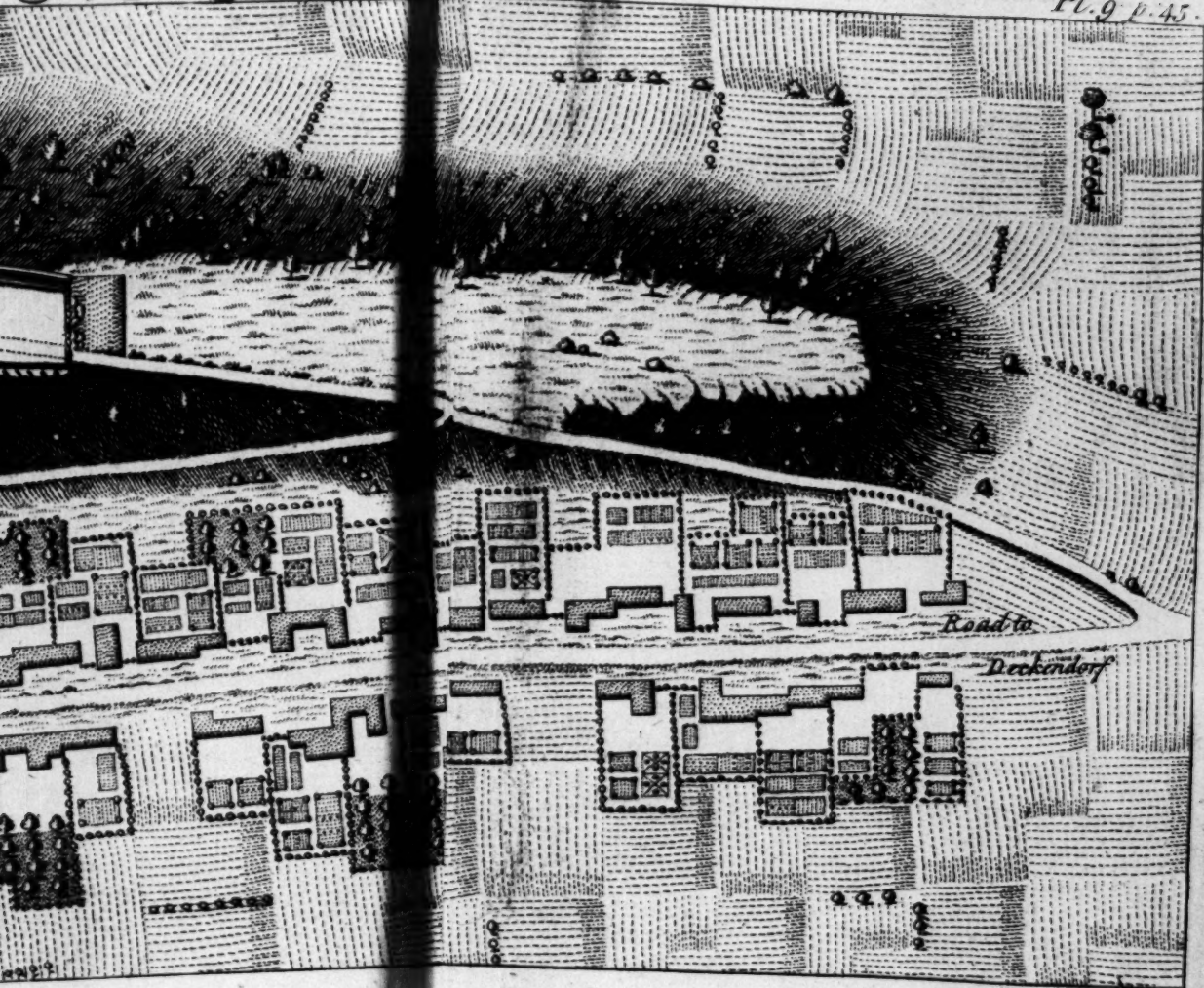
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holes made in the most convenient place  
large enough to serve for embrasures for  
some small pieces of cannon

RBERG a Castle near Deckendorf.

Pl. 9 p. 45.





ENGINEER

It is also absolutely necessary to repair the  
breast-works in the wall of the bastion, with  
stones, or to close them with palisades,  
to defend the bottom of the ditch, to form  
a barrier of earth, and to render the road  
impassable, when the enemy approaches, by  
planting trees, &c.

The posts thus repaired and provided with  
stores, with 3 or 400 men for a garrison,  
could be in a condition to sustain a siege.

The first of May in 1742, I received  
orders to fortify the castle of O, a country  
town situated between Dordrecht and Rotterdam,  
in which it is about a league distant.

My works were neither remarkable for  
ingenuity or expense, they were simple  
and trifling, but the action which I had  
in view, proved that these trifles were sufficient,  
and the detail may be of some use to  
young engineers, or one who has had little  
experience in this part of his duty.

This castle is built on the summit of an  
eminence, the access to it is impracticable on  
the side, and very difficult on two others.  
A plan annexed, which must be attended  
to in reading the report, will explain  
itself.

My first attention was to mark the doors  
of the breast-works of the bastion, placing two  
mills the other, and throwing in immediately  
from 8 to 10 feet, just as I found it necessary  
to cover the adjacent bastion, and make  
holes at every three feet.

There

It is also absolutely necessary to repair the breaches in the wall of the *Esplanade*, with dry stones, or to close them with pallisades, to pallisade the bottom of the ditch, to fraise the parapet of earth, and to render the road impassable, when the enemy approaches, by felling trees, &c.

This post, thus repaired and provided with stores, with 3 or 400 men for a garrison, would be in a condition to sustain a siege.

IV. The first of *August* in 1742, I received orders to fortify the castle of O, a country-house, situated between *Deckendorf* and *Regen*, from which it is about a league distant.

My works were neither remarkable for their singularity or expence, they were indeed trifling, but the action which I shall speak of, proves that these trifles were sufficient, and the detail may be of some use to a young engineer, or one who has had little, or no experience in this part of his duty.

This castle is built on the summit of an eminence, the access to it impracticable on one side, and very difficult on two others: the plan annexed, which must be attended to in reading the sequel, will explain the rest.

My first attention was to mask the doors with breast-works of firr-plank, planted one against the other, and elevated without from 8 to 10 feet, just as I found it necessary to cover the adjacent heights, and made loop-holes at every three feet.

These breast-works, whose sides flanked where it was necessary, have a banquet, and that of the great gate, the only one not closed up, a barrier of planks with loop-holes.

The rear-court and the barn had no communication with their breast-work, but what were so low, as not to be discovered from without.

All the exterior openings, for 9 or 10 feet from the ground, were at the same time walled up, to guard against fire, a common expedient of the enemy; and, as we did not want planks, I ordered the windows to be masked, 6 feet from the floor, to cut loop-holes in them, and in the doors.

Such were my general precautions; the top of the little barn, and the walls of the great one were of good masonry, and our breast-works defended this front pretty well, the only one easy of access.

The side next the river, was inclosed with high solid walls, accessible only on the side opposite the bridge, and flanked by the hog-house, the tower next to it, and the breast-work adjacent to the tower: there was nothing to fear in the rear, and the sides of the brew-house were carefully built on a steep rock.

From thence to the pavilion, and from the pavilion to the little barn, the wall was from 6 to 7 feet high, along which we threw up a banquet: this side being weaker than the rest,



rest, I ordered some loopholes to be made in these buildings: from the brew-house to the pavillon, the hill is very steep, but of an easier ascent afterwards: the garden on the outside was enclosed by planks nailed to posts; I ordered it to be pulled down, and also a dry stone wall three feet high, which parted the terrasses, and which would have served the enemy for a parapet, by kneeling on the ground: these two terrasses I ordered to be made into a glacis, and every thing to be cut down that might obstruct our view.

The little barn, with which I shall finish the description of the inclosure, was certainly the most dangerous place, because three of its sides were of wood, and I was afraid, that if the enemy set fire to this, it might communicate to the great one, which was much higher, but covered with shingle, or cleft wood.

In my report, I proposed to pull it down, and close that space with a breast-work of the same construction as the rest, and turned so as to flank the adjacent parts; I should have done it of my own accord, but the design being to make this castle a magazine of forage, we were obliged to preserve places proper for concealing it from the sight of the enemy, since we could not keep them at a proper distance: I therefore supported a parapet of well beaten earth, by the wall of the garden, and where the slope would not permit,

E

mit,

mit that, I doubled it with a brick wall, built with clay, instead of mortar.

If I have explained myself as clearly as I could wish, it will appear, that the side of the garden was the only place that could be forced without cannon; and if the enemy had got over this wall, which was almost intire, I will venture to say, they could not advance much further.

By raising a new breast-work on the side of the court, and opening some old doors, I had a free and sure communication through the stables, from the castle to the great barn, and its breast-work; it was possible to prolong this communication even to the brew-house, by a row of palisades, but that was a considerable encrease of work; a wall must also have been broke through, which was not without its inconveniency, and the brew-house high, and solid built, was in a very good state to do without that assistance.

All the windows and doors of the buildings being shut up to a proper height, and loop-holes made in them, it is sufficient to cast an eye on the plan, to be convinced, that the most obstinate enemy, could not keep their ground in the court, crossed by so many fires.

V. A succinct account of what passed a few days after, will the better justify these precautions.

The 9th of the same month, in the afternoon, this castle was invested by about 800 men,

men, from the garrison of *Passau*, and the camp of *Mr. Kevenbullaer*, among them were 400 grenadiers, some pandours and hussars.

*M. Darmeville*, captain, commandant of a battalion of *Picardie*, held this post with 50 men, the independent company of *Regen*, and 80 dragoons of that of *Jacob*, who, being prisoners of war, were of no service: the French commandant was often summoned to surrender on honourable conditions; there also came an hostage to him, that he might send and reconnoitre the number and kind of troops by which he was invested. *M. de Poussac*, captain in the regiment of *Normandy*, one of the detachment, was charged with this commission: he found the 400 grenadiers behind a hill, but neither this, nor the confusion of so many horses in so small a place, nor the fear of the forage, scattered up and down the court, could damp the resolution of these officers.

The sight of the breast-work, which almost covered the front, made that side appear not very easy of access; the enemy therefore attempted the attack opposite the mill, which they burnt; their design was likely, to climb up under cover of the brew-house, and slip along the surrounding wall, but finding the slope so steep, and the pavillon loop-holed, they quickly turned to the weakest side, that is, towards the garden, where they had but one of these obstacles to surmount. The besieged, without the least hurry or  
E 2                      confusion,



confusion, never fired but in good time, and by order of the commanding officer; they killed some pandours, who, supported by their small arms, attempted to set fire to the little barn in the night, with torches fixed at the ends of long poles. This ill success discouraged the rest, and finding they could neither set fire to the building, nor disorder our troops by their frequent discharges, they retired at one in the morning, to some distance, to consider what method they should take to succeed.

The thing was difficult without cannon, and *M. Saxe*, who had taken the command of the army, the same day of the attack, had not given time to bring any. This general being informed of what had passed, ordered a general forage, the next day on the left, where he marched in person: under this pretence, he detached by different roads, two corps of infantry and dragoons, who disengaged this post, and would certainly have either taken, or destroyed the 800 men who attacked it, if too much ardor had not prevented their strictly conforming to orders, of not appearing, but all at once, to cut off their retreat.

VI. If my design was only to give my own ideas, and treat of works of this kind, which I have executed, perhaps I should have nothing more to add here; but as my view is quite different, I shall finish this chapter with some observations, chiefly drawn from an author,

thor, who is the more clear on this subject, as he had frequent opportunities of experiencing them.

1. *M. de Folard*, the only one who has wrote on this head, prefers walls of brick, and even the thinnest of them, to those of stone, because cannon only makes holes in them; and in stone, where it makes a breach, the splinters do great mischief.

2. He recommends carefully to guard against fire, and consequently, if the building is covered with thatch or boards, to pull down the covering and burn it immediately, lest it assist the enemy in annoying you; as to the boards, they will always be of use.

3. He proposes to stop up the door, especially if it be large, with a tree or two, with all their branches cut and sharpened at the ends, which he says is better than the best barricaded door. This has certainly a good effect, but I do not see, why he would rather have the door open, as he afterwards mentions, than to have loop-holes in it: he says nothing of the windows.

4. He would have the loop-holes below, 3 or 4 inches wide, and  $7\frac{1}{2}$  or 8 feet from the ground, that the enemy may not fire through them, and about 2 or 3 feet distant from each other, that they may not get to the roof, without being exposed; above all, he recommends to pierce the angles.

5. Besides these loop holes, he proposes others below, under the intervals of the up-

per ones, and only one foot from the ground, digging a trench 6 feet broad, and 3 feet deep,  $2\frac{1}{2}$  feet from the wall within side. By this means you discover the legs of the assailants, which when near, cannot be seen from the upper ones: this is an excellent thought; I would only recommend that they be even with the ground, and not more than 6 inches high: the trench need not be deeper, because they may fire kneeling. The banquetts of the upper loop-holes must in this case be planks.

6. For fear the enemy should gain the roof, which we here suppose tiled, it must be scaffolded, so as to be defended by some holes made in it.

7. He advises to provide a number of stones, to throw down, especially at the angles, where the enemy will attempt to sap.

8. If for want of men, or other means, you are obliged to quit the lower part, he recommends, to use all possible means to keep the enemy out of it; therefore holes must be made in the upper floors, especially towards the doors, to fire down through: this *M. de Saxe* practised, when he defended himself a whole night in a country inn, with 18 men only, against a detachment of 200 dragoons, and 600 *Polish* horse, who could neither force nor take him, though wounded.

9. When you can only possess part of the upper rooms, *M. de Folard* proposes to break up the floors of those you abandon in many places,



places, at least before the doors, a little more than their breadth, so that this opening may serve as a ditch; but it is necessary to have an eye below, lest the enemy get through them by ladders.

10. Lastly, if the doors are slight, and if they attempt to break them with hatchets, he would have you retire to some distance, and to keep firing at the place from whence the noise comes: it was thus practised in *Italy* at the defence of the castle of *Bouline*, 1705, celebrated by this action.

The reader must doubtless perceive, that the most part of these rules agree with the different articles of this chapter, by adding what I have said on each in particular, I believe little more can be desired on this subject. I shall however join some reflections on the attac, an object always to be had in view, when we are treating of the defence.

Supposing the post in condition, and sufficiently provided with troops, and that the enemy have no cannon, they are then reduced, as *M. de Folard* observes, either to scaling the roof, undermining the walls, or making a breach with a beam, suspended between four posts like a ram; now it appears impossible to me, that any of these means can succeed, as long as ammunition lasts, or the defendants preserve their senses.

When you are obliged to abandon the ground-plot of the building, there is nothing to fear, in my opinion, but fire and smোক,

things very difficult to guard against ; it should therefore be defended as long as possible.

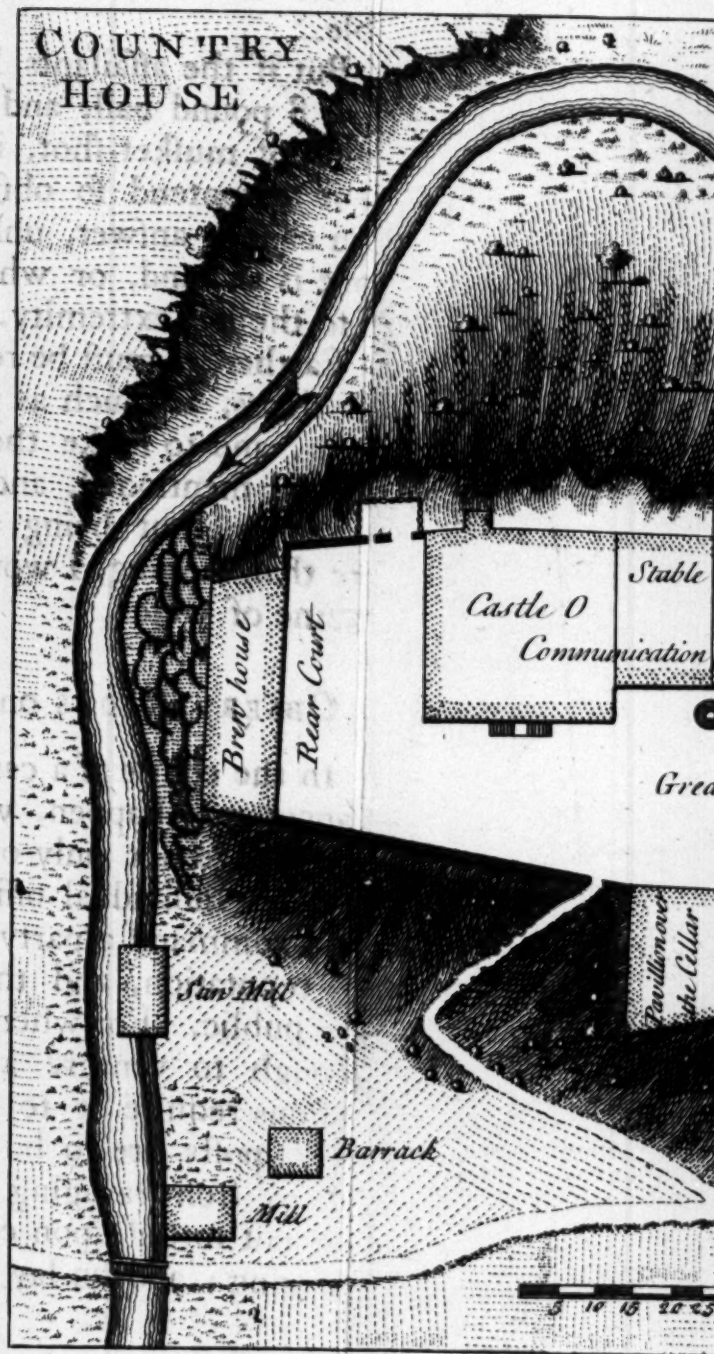
But if the assailants have some cannon of 6 or 8 pound ball, and these placed out of reach of musket-shot, it does not seem prudent to contend so obstinately against a fire you cannot answer, unless you know assistance is at hand, or when ordered to defend it to the last extremity.

Farther, it must be remembered to defend the doors, as much as possible, to flank the walls, and to make the little *Machicoulis* of wood I mentioned, and to collect a number of stones ; but being more apprehensive of fire than sapping, I would rather have a magazine of water.

#### OBSERVATIONS on the third Chapter.

In the course of a campaign many circumstances may happen, where the sagacity and knowledge not only of engineers, but also of every individual officer who commands or may command a party, may be displayed to his reputation, and the great advantage of the public. For when an army is not strong enough to venture a battle, or some other reasons require it to be upon the defensive only, posts are to be taken to restrain the enemy from ravaging the country ; parties are sent to fall upon convoys or stragglers in foraging ; and to lay hold on all opportunities

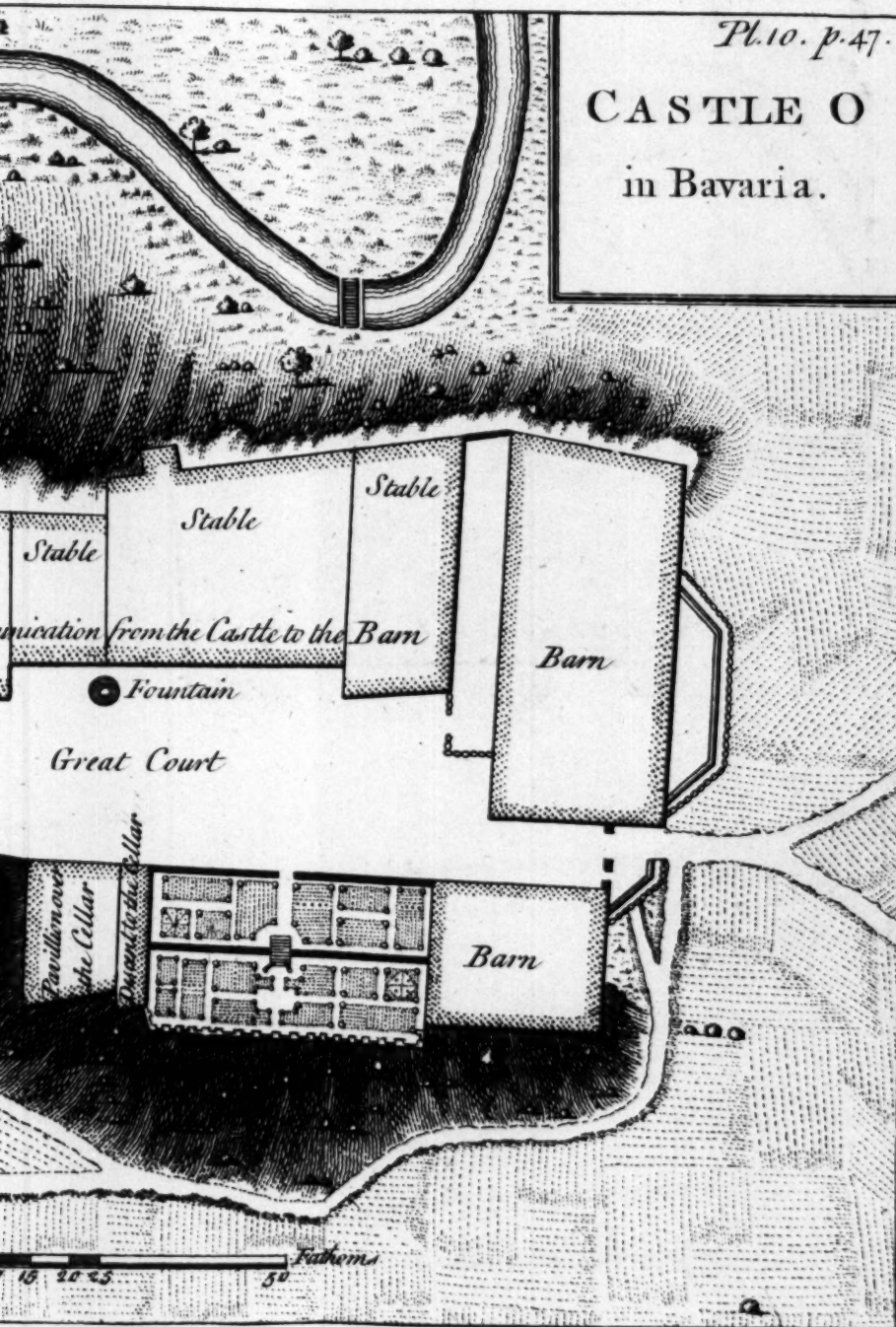
# COUNTRY HOUSE





*Pl. 10. p. 47.*

# CASTLE O in Bavaria.





ties to defeat all schemes of the enemy; which being done with success, often reduces a superior enemy to an equality before the end of a campaign.

It is therefore required to make use of country-houses, church-yards, or villages, in case of being overtaken by a superior party of the enemy, and to barricade or fortify them by some small work or other, in order to gain time, either for being succoured, or escaping in the dark. All this the author has endeavoured to explain by such examples in which he was chiefly concerned, in so clear and instructive a manner, as requires very little else to be said on the subject. I shall only observe, that in the example cited of M. *Saxe*, when he defended a house with 18 men against 200 dragoons and 600 horse; there is to be added, when it was dark he sallied out of the house, his men having their bayonets fixed, with order not to fire, by which means he escaped and got into a wood, where he could not be pursued.

In the last war in *Flanders*, an ensign of ours was placed in a village, with a party of men, through which the *French* intended to pass with a considerable detachment; it happened luckily that there was a young engineer with this party, who advised the ensign to have the principal street barricaded, and to throw up an intrenchment cross the road at the entrance of the place; which being done, and men placed there; when the  
*French*



*French* saw the good countenance of our troops, and their disposition, went another way, imagining that there was a much greater force than appeared; and the ensign was rewarded with a company for his behaviour, though in reality the honour was due to the engineer, who advised him to this bold step.

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## CHAPTER THE FOURTH.

- I. *Fortifying small towns and other considerable places.* II. *Advantages and disadvantages in regard to the disposition and construction of the houses.* III. *Inconvenience of their great extent.* IV. *Means of correcting it in certain cases.* V. *Inconveniencies almost always insurmountable.* VI. *Places to be intrenched for a day of battle.* VII. *Communications to be established from a post to a bridge; first example.* VIII. *Second example.*

I. **V**ARIOUS circumstances, such as the necessity of keeping an enemy at a distance, preserving communications, securing from surprize a body of troops in winter quarters, or quarters of refreshment, often oblige to fortify larger places, than those already mentioned.

An engineer must, in this case, carefully examine the situation of the place, the nature of its environs, the disposition and construction

struction of the buildings, the extent of their circuit, what troops it can contain, that is to say, what number can be encamped or quartered in it, according to the season.

He must examine at what distance the nearest woods are; if the roads are good or bad; the number and kinds of workmen and tools, and the number of carts and beasts to draw them, on which he can depend; in fine, what assistance he can procure in the place itself, and what are near at hand.

These attentions are all equally indispensable; a village, and even towns commanded by eminences, such as *Donauvert* and *Deckendorf*, are always very bad posts. A precipice at all times, and, except in great frosts, a river with steep banks, a place that can be laid under water, a deep morass, a low ground and full of ditches, are always advantages, if they are at a convenient distance from any part of the intrenchments: so much of the intended work is thus lessened, and a very essential point gained; for on these occasions, there is seldom any other workmen than those to be had from the troops, designed to guard the place, and their number is commonly regulated by what it can contain.

When a place is intirely furrounded with an intrenchment, a single ditch, if it is not deep and full of water, is seldom sufficient to stop an enemy: it is therefore useful, and often necessary, to pallisade and fraise; besides, there must be bridges and barriers  
which

which require wood, carriages, workmen and tools.

II. How important soever such assistance may be, one is sometimes obliged to do without it: one may in part supply it, by the means I shall speak of in treating of the construction.

There are places so advantageously situated, that they seem intended to be intrenched: such are those on the brow of a steep hill, or which occupying the bend, or conflux of rivers not fordable, are naturally inaccessible for the greatest part of their extent.

On the contrary there are some, which, on account of defects not to be remedied, ought absolutely to be rejected, as incapable of any defence; such among others, are those which are commanded by adjacent heights, from which the parts liable to be attacked cannot be covered: this maxim, though truly evident in itself, yet regard must be had to circumstances attending it: the part commanded, for example, may be inaccessible, and on the side exposed to the attack, covered by houses; in that case, such a place may be defended, since some little posts are sufficient in those places that are commanded; which may easily be sheltered and secured from danger, and preserve their communication by some adjacent building.

It was thus I proposed to establish a post in the church-yard, of the suburbs of *Dekendorf*, situated at the foot of a hill, almost perpendicular,



perpendicular, but partly covered by the church: the intent was only to contribute to the preservation of a communication from the suburbs to the town, and from the town to the *Danube*.

III. A village situated in dry and even ground, such as affords no advantage, is seldom proper for the use we are speaking of.

What is here esteemed a great defect, is, generally speaking, a circumstance to be desired in fortified places; but though the rules of fortification may hold good in both cases, yet they are very different: in one, we work at leisure, and with all things necessary; in the other, the time and means are limited.

There is a necessity, therefore, of drawing from the situation such assistance as may abridge the work; it is, as I have shewn, of various kinds; the disposition and construction of the buildings, sometimes furnishes the same advantage as a good situation.

When I arrived at *Donaufaust*, in September, 1742, I found some officers of the two battalions quartered there, employed in intrenching that town. The castle, from which no other assistance could be expected, for want of loop-holes and scaffolding, covered part of it by its height: a hill of great extent, inclosed by a wall, and the contiguous houses, greatly shortened the work. I was otherwise employed, and had only one engineer with me: I advised them, and they succeeded so well, that in a few days, having received

received advice that the enemy seemed disposed to attack them, they found themselves in a good posture of defence.

When the houses, though separated from one another in many places, do not form a very long figure, and as in large towns, are built and covered so as not to fear fire, they may be useful, by making loop-holes in them, and in the intervals throwing up some intrenchments, that may flank each other, or be flanked by those buildings which project pretty far; it was thus I proposed for one part of the suburbs of *Deckendorf*.

But if the houses are of wood, as in *Bavaria* and *Bohemia*, or of earth and thatched as in *Flanders*, they are only fit for habitations, and are otherwise more dangerous than useful.

IV. The greatness of the circuit, adds to this inconveniency, and in regard to circumstances, sometimes forms an insurmountable one. I found myself in this case at *Pilsing*, a town situated on this side the *Iser*, half a league from *Landau*. Its position made it proposed to quarter some troops there, and was resolved upon, as soon as it was known that the *Austrians* had taken possession of it.

I was sent from the army the 14th of *November*, that is, two days after the surrender, and having received orders to intrench the town, I carefully examined it, and quickly discovered most of the defects I have mentioned; it is not commanded on any side, its environs

virons are also cross cut with ditches and drains, and almost throughout marshy : but the winter approached, and is very long and severe in *Bavaria* ; therefore these advantages of nature, that ceased on the first frosts could not be relied on : besides, of 70 houses which were in *Pilsting*, 7 only were of masonry, and the rest of wood.

We were consequently under a necessity of intrenching it entirely, or at least to fortify its bounds by such works as we shall treat of, which was not even practicable.

This new difficulty proceeded from the houses being mostly separated from each other by yards and gardens ; their circumference, tho' they formed four different streets, could not be reduced to less than 850 fathoms.

I perceived that this place would only quarter one battalion, which was neither sufficient to fortify or defend it.

This reason alone was unanswerable ; but I should likewise have had great difficulty to get as many palisades as necessary ; the *Rindal*, a little wood, one league off, towards *Straubing*, being entirely cut down, we should have been obliged to fetch them farther off, and the few horses and oxen, which the *Austrians* had left, were not sufficient, especially with bad carriages and worse roads.

Tho' the church-yard was spacious, and enclosed with a good wall, and it was easy to make a communication with three houses of stone, and two of wood, which joined it, the



the enemy not being able to get thro' those of wood soon enough, if they did set fire to them, not to leave us sufficient time to support, or at least to barricade the opening they should make; and as this particular post, good only for a last resort, decided nothing in our favour, as we could not make use of it without abandoning the town, the sick, the stores, and the baggage, I did not hesitate to conclude, that *Pilling* was incapable of being entirely fortified.

V. There are circumstances, which oblige to sacrifice the interests of private people for the publick good: there are even cruel wars, where the necessity of the reprisal forces in some measure the devastation which it authorises; very terrible circumstances, and which an engineer should never practise without particular orders, and which he should very seldom demand.

It is plain, I would speak of those occasions where the useless parts are destroyed, to preserve with much less work those that are useful. Had we been in this case at *Pilling*, and that part of the town most compact together had been sufficient for our purpose, all would have been easy, at least very possible.

By levelling the houses, which extended along the roads of *Straubing* and *Deckendorf*, the circuit would be shortened more than 200 fathoms, that is, about a fourth, and very little quarters would have been lost.

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That was a great deal, yet inclosing the remainder, seemed too considerable a work for one battalion, weak as they always are at the end of a campaign, and pushed perhaps, by the unexpected march of the neighbouring troops, to hasten the intrenchment: I believe that on these occasions we may have recourse to the expedient I shall here propose.

Having determined the figure of the inclosure in the most convenient manner, raise at the angles redouts in the form of Bastions, whose fire crossing in the intervals, reciprocally graze the faces of these little works.

The Plan will explain my design: five Plate XI  
sides of the exterior polygon are of 100 fathoms each: they may be of 120, or even 130. The perpendicular is one twelfth of the side; the faces are 12 fathoms, and the flanks perpendicular to the lines of defence.

The sixth front is near 150 fathoms, but it is better defended, as the faces are grazed by the wall of the Church-yard, and the two parts of this wall, the most projected, are also grazed by the flanks of the adjacent Bastions.

This figure is no more than a Polygon fortified after the common method, excepting, that there are no curtains. The *Redans* would have been of more extent than these redouts, which are substituted in their room; I therefore save all the curtains, that is to say, more than 420 fathoms of work; for

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reckon-

reckoning 50 fathoms for each redout, the 720 fathoms, which were to have been made, are reduced to 300.

As to the defence, 50 men in each redout, as many in the church-yard, and the rest of the battalion drawn up with the grenadiers, in the properest place to support where necessary, are sufficient.

I don't know that this scheme was ever executed, or even proposed: yet it is so plain, that I cannot think it new; whether it is, or is not, it may be useful in certain Cases.

Having given an account of its advantages, it is but right to expose its defects: in a quarter not inclosed, such as this, the soldiers may straggle in the night, the peasants may have dangerous communications, and a resolute body may push thro' the intervals.

It is the commandant, or the engineer, charged with the project, that should examine if he can do better, in regard to time, and the number of Workmen: in this manner a post is quickly put into a state of defence, which, according to the common method, cannot be done but with a vast body of men: this advantage is a real one; besides, if we have time, or should hasten a little more, nothing prevents our perfecting the enclosure with a parapet of earth, or by trees, or any other kind of barricades.

VI. Whatever number or variety of expedients experience and imagination may suggest,



gest, yet places are sometimes found in a plain, as at the foot of mountains, which we can turn to no advantage.

The greatest part of villages are thus situated; the houses commonly extend along one or two roads that run through them, the rest is only courts, orchards, and gardens, enclosed with very bad hedges, narrow ditches, walls of mud, dry stone, or wood, which renders the circuit exceeding great, in proportion to the number of houses: such is *Schleitel* on this side the *Loutre*, only composed of two rows of houses in right lines, and separated from each other; and is at least as long as *Straßburg*, including the citadel.

When houses are built, or covered with combustible matters, it is, as I have already said, another inconveniency: I found them all united at *Bischoffmais*, a village, three quarters of a league this side O castle; and designed also for a magazine of forage. The church-yard, the ordinary resort in like cases, could not defend the barns, because of its distance; besides, being narrow, and surrounded almost every where with houses of wood, which commanded it, I saw that the enemy had it in his choice, either to fire on, or burn those that defended it.

I examined the village, according to my orders; but I proposed nothing for its defence, because it appeared impossible to me to do any thing: so that the lieutenant which

was left there with 30 men, owed his safety, and that of his men to his own skill.

During the attac of the castle, some men having appeared to reconnoitre it, he took the only advantage to be taken, which was to retire into the church, barricaded its avenues, and made loop-holes with scaffolding, the use of which I had shewn him : chance favoured his precautions, and saved the magazine ; twenty volunteers who were escorting a small convoy of bread, going to *M. de Grassin* on the frontiers of *Bobemia*, finding the roads stopped up, joined themselves to him ; they had two drummers with them, which the officer made good use of ; for at the usual hour of beating the retreat, he ordered them to beat that of the infantry and dragoons at the same time, and it was this stratagem, perhaps, that made them postpone attacking this, till after the taking of the principal post, which as I have shewn, could not be forced.

VII. Thus the greatest difficulties to be surmounted in fortifying small towns and villages, are the disadvantages of a commanded situation, of an inclosure of great extent, and the dangerous construction of the houses, which will not permit to use them in the defence.

We have hitherto supposed the most ordinary cases, that is, a detached post or quarters to be secured ; but there are others, where different circumstances oblige us to be

be regulated by other maxims. Such for example, is the fortification of a village, intended to be of service in a day of battle : whether it be advanced, or in the line itself, or on one of the wings, it signifies little, and is often more useful than hurtful, that it be commanded, provided it be only in the rear.

The number of troops to be employed in it, not depending on what the place can quarter, the inconveniency of its great extent, and even of the combustible materials employed in its construction disappear ; as the principal use of the houses is to hide any necessary motions from the enemies sight, all that may be hurtful must be inclosed, not regarding the number of workmen and troops such works require.

What is most essential, and particularly to be regarded, in this case, is in my opinion, to have as large flanks as possible, because there is not the stratagems or feint attacks, but the effort of a column to be resisted ; to lay open the environs, by cutting down all trees, hedges, &c. within two feet of the ground, that the artillery may have the greatest effect possible, which is here absolutely necessary ; to incumber the ground before it, and on its flanks, that the enemy may not advance without being broke ; and to level all in the rear, that the troops may return to the post with force, and



in good order, in case necessity should require it.

When the village terminates the line, the intrenchment must be lengthened by a return gibbet-wise, and the exposed side incumbered, to guard the better against being flanked by the enemy.

A favourable situation, especially, if it just rises so as to command the parts to be battered, is always a great advantage: many circumstances, which in other cases are considerable obstacles, are not here to be regarded, and vanish by the means we have of supplying their defects.

This article is more essential to an engineer than is commonly imagined: few battles have been fought without such posts, and that of *Fontenoy* is an example of what importance they may be.

VIII. When the town or village is advanced before the army, and at some distance from a river, and consequently from a bridge, the town must not only be fortified, but the passage to the bridge must likewise be well secured, that so essential a communication, as well for succours as a retreat, may not be cut off.

I was twice intrusted with this charge in *Bavaria*; *M. de Balincour*, possessing the risings which commanded the openings of *Dingelssing* beyond the *Iser*, the enemy being masters of *Landau* only six days, abandoned it;

it; I received orders to put that place into a state of defence as soon as possible.

It is situated on the brow of a little hill, of which it occupies the whole breadth up to the top: two gates, one below, another above, divide the surrounding wall, almost into two equal parts: on the right of the entrance of that side, next the river, the wall is low, and no more than two feet broad, it almost every where joins the houses; but it is not commanded, and the ground on which it is built is so steep, as to be impracticable to pass it. I observed that the floors of the houses might serve for banquets to the loop-holes, and that it was easy to build wooden ones in the courts, yards, and such like places I found round the wall.

On the left, the wall appeared in better condition, except in one part, where it was propped up, and consequently must be intrenched; it was between 4 and 5 feet thick; a little roof, which covered the wall in places where the houses did not touch, was a protection from the rising grounds, and there needed only some slight repairs, and to break through some houses, to have a communication from one gate to another: this side has a broad and deep ditch with a steep slope.

There were breast-works and folding-gates, with their barriers at the two gates. The inclosure, speaking in general, had neither towers, nor flanks; but I found they might soon be made, and at little expence, by a

method I shall speak of in treating of the construction; so that by this assistance, absolutely necessary against scaling and sapping, I flattered myself, I should in a few days put the body of the place into such a state of defence as not to be forced without cannon.

The suburb is almost of as great extent as the town; I could not avoid preserving them, as well for the necessity of quarters at that season of the year, as to inclose the spot where a bridge was to be built, in the room of that burnt by the enemy. This suburb was commanded by a considerable rising very near, resembling a truncated cone, on the top of which was a large chapel. I proposed to possess these eminences by redouts, which should communicate with the ditch of the place, and to raise some others at proper distances, in the flats of the *Iser*, to be joined together by a little parapet, surrounded by a wet ditch. These precautions were sufficient on this side; on the other, a simple intrenchment, well pallisaded, would inclose the short space between the steep hill and the river. This is sufficient to show what may be done on like occasions; it would have been the work of a very few days, but I had not time even to begin it.

IX. While the greatest part of our troops were forming on the other side the *Iser*, *M. Saxe* driving all before him that attempted by favour of the defiles, to oppose him in his march, advanced on the other side the *Danube*; it was resolved to return to *Deckendorf*.



*dorf.* M. le Comte d' Aumel, commanding in chief the engineers, ordered me, when I least expected it, to join him; which I did the same day, returning by *Straubing* to *Ober-Alteich*, the general rendezvous, and from thence to *Pogen*, our particular quarter.

Our little army, which we then called the reserve, cheerfully embarked the 2d of *December*, on the *Danube*; (except the cavalry who took the common road) and though often closely pursued by the hussars, who drew up in order within pistol-shot of the river-side, arrived at *Deckendorf*, a little below the ruins of the bridge we had burnt three months before, when we marched for *Bohemia*.

The enemy surprized, at our sudden arrival, and by that rout, abandoned the place after some discharges of cannon; so that instead of being employed in second, at the siege, according to my first destination, I was to put this place into the best state of defence.

This would have been an easy matter, was it not for the heights, which rather plunged into it, than commanded it: it was sufficient to repair the banquetts of the body of the place, to renew the platforms in the towers; and in case of an attac, when the spot was once determined on, to raise on the right and left, from the principal wall, to that of the *Fausbray* intrenchments, with pallisades joined, and with loop-holes, and ready prepared, which would flank the troops with a cross fire,

fire, who should endeavour to force a breach, and which we in the mean time would have intrenched and barricaded within.

As to the principal suburb, the proximity of the *paung*, and of the hill, otherwise so disadvantageous, the situation of the church-yard, the great extent of the court of the parson's house, and the inclosure of the capucins, were very favourable circumstances.

Plate XII. I was charged with the town and the plain, that is to say, to repair the body of the place, to intrench the suburb, and to preserve a communication with the *Danube*. The plan will save me a tedious detail; I shall therefore confine myself to some notes on it, where it requires an explanation.

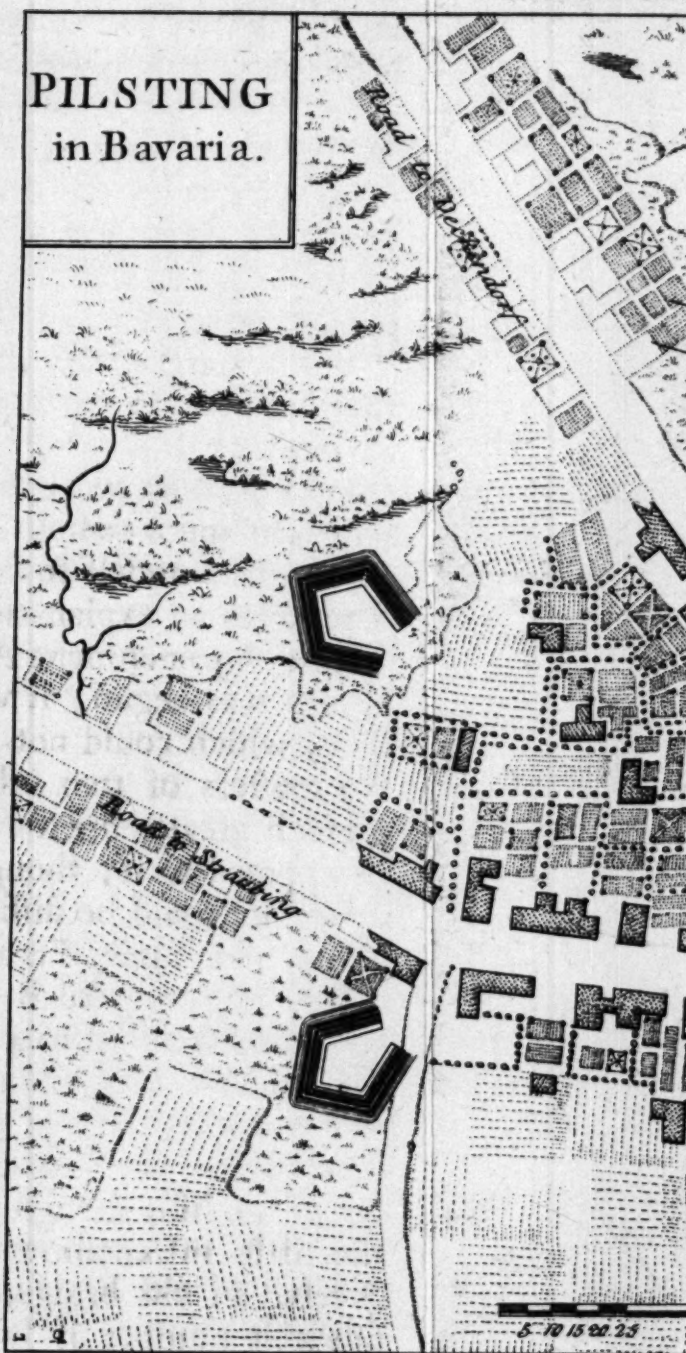
The intrenchment A at the head of the suburb was begun; it was covered by a redout, which could not be taken without being masters of two others, and it presented a much greater fire on the defile than could be opposed to it; though good against a surprise, it would be difficult to be maintained in a general attack, because of the heights.

The church-yard B is a terrace, raised 18 feet, and lined with a parapet of good masonry, with large loop-holes: the church, and two rows of large pallisades, would have covered the party possessed of it, from the fire of the hill, though almost perpendicular: the little intrenchment C which flanks it, covered an old bridge, and inclosed a considerable number of houses.

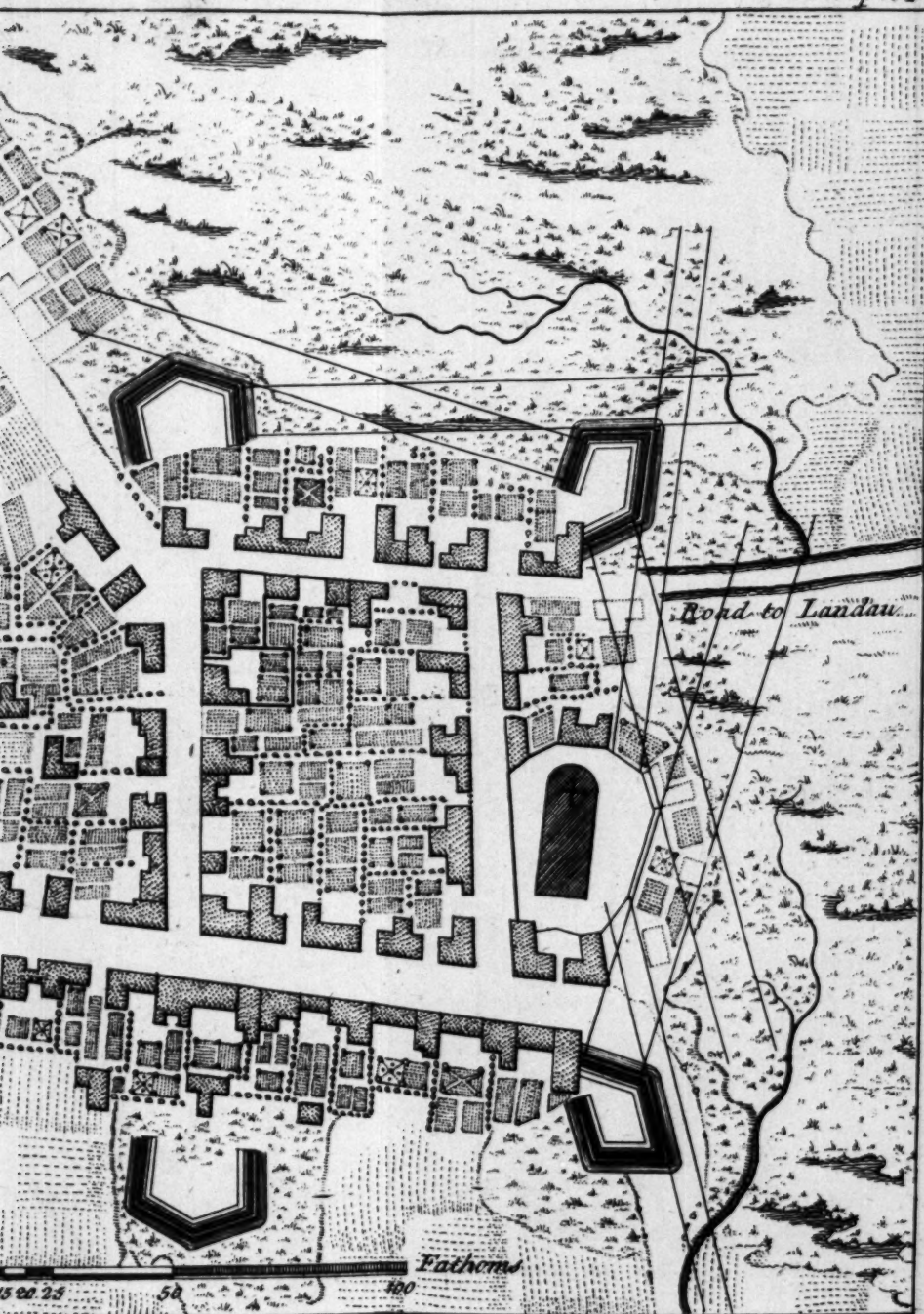
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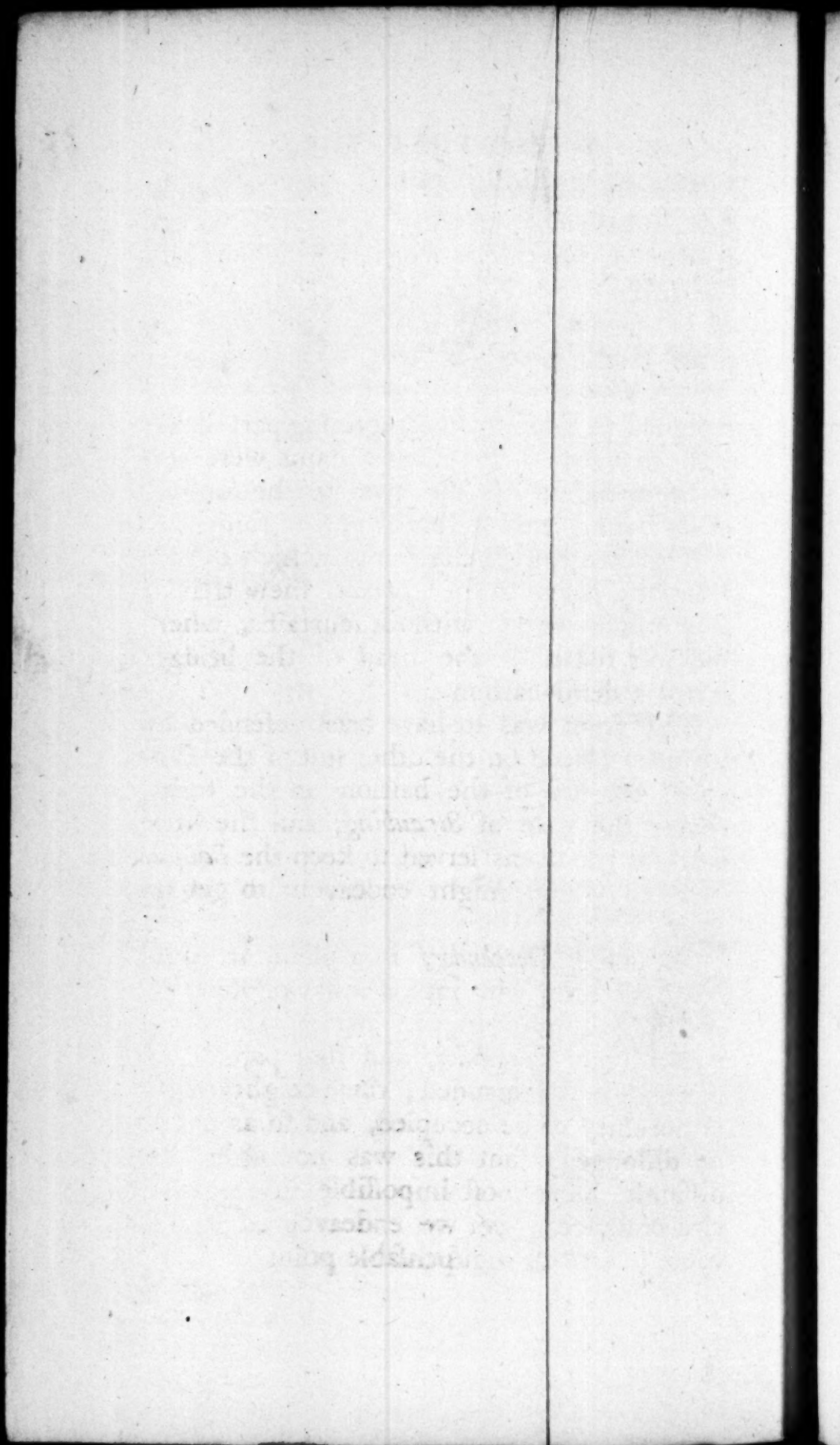
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in Bavaria.









The intrenchment D (proposed to supply this, in case the inclosure was found too extensive, or the troops too much dispersed in the different posts) and that of F are designed to cover a communication, open from the place to the *paung*, as well by the gate of *Nider-Alteich*, as by the postern E, which I designed to make, when repairing part of the wall that was fallen down: dams were also to be made, to fill the river to the summit of its banks, that it might not be forded.

The direction of the works, which extend from the *paung* to the *Danube*, shew that it is a crown-work, without curtains, where the left redan of the head of the bridge, forms a demi-bastion.

The front was to have been defended by batteries placed on the other side of the *Danube*: the fire of the bastion on the right, covers the gate of *Straubing*, and the little work at the ovens served to keep the *Saiques* in awe, which might endeavour to get up again.

Supposing *Deckendorf* in a plain, it could not have been put into a state of defence, and the communications preserved, with fewer works; but *Deckendorf* and that part of the shore were commanded; these heights ought of necessity to be occupied, and so as not to be dislodged; but this was not only very difficult, but almost impossible in regard to circumstances; yet we endeavoured it, because it was an indispensable point.

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*M. le Comte d' Aumale* himself, traced the three redouts marked in the plan ; they could not be better disposed ; but these posts necessarily required a number of troops to possess and support them, therefore he depended only on the state regiments are in, at the end of a long and laborious campaign, and our cantonment was sufficient to furnish the whole ; but though the common time of sickness was passed, those that remained in health, six weeks afterwards, that is, at the end of *January*, were hardly sufficient to guard the colours, much less to maintain themselves in a post so disadvantageously situated ; on which account, and the hardness of the earth, caused by an excessive frost, we had only traced one part of the works, and even that, far from being perfected, was no more than begun.

We shall conclude this chapter, by observing, that the preceding examples, not only shew the manner of making use of old inclosures, to retrench suburbs, making bridge heads, and to secure communications ; but likewise that an engineer, how disagreeable it may be to be employed in situations where art cannot rectify nature, should endeavour, without being discouraged, to lessen the evil which he cannot intirely remove.

#### OBSERVATIONS on the fourth Chapter.

The author treats here the manner of intrenching posts of a great extent, either to contain

contain a considerable part of an army, during the summer season, or for winter quarters; or sometimes to secure a large magazine of forage, or the heavy baggage of an army.

A post, surrounded partly by a river, and partly by impassable marshes, may be easily intrenched, and defended with a small number of men, during the summer season, but cannot be maintained in winter; because, the frost would render the passage over the river or marshes as easy as dry ground: it requires therefore, different conditions to fortify a post in summer, from those of one in winter.

The most important attention of a general ought to be, that of securing his magazines of forage and provisions, in such a manner, that the enemy may not be able to destroy them, either by surprize or by open force: they ought to be as near the army as can conveniently be done, that the convoys may not require too great a party of men; which would fatigue the troops too much; all wood and defiles between the magazines and the army are to be carefully avoided: and in case the army is obliged to move farther off, either to retreat before a superior enemy, or to pursue; the magazines must move also, or new ones are to be formed. I am persuaded, whoever considers attentively, the importance of these precepts, will agree, that this part of generalship is one of the most essential, in the carrying on a successful campaign:

paign: many examples might be given, that have happened in this present war, where these precepts were not so well regarded in all appearance as they should have been, both by us and our enemies: but as our design is only to inform the reader of what should be done, and not what has been done, we shall proceed no farther.

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## CHAPTER THE FIFTH.

- I. *Intrenched camps; their use.* II. *Their position:* III. *Encampment of troops.* IV. *Intrenched camp of Russenheim; first scheme.* V. *Second scheme, with reflections.* VI. *Enquiry into the interior of the first.* VII. *Third scheme.* VIII. *Defects of the first and third.* IX. *Intrenched camp of Spire.*

I. **W**HEN there are reasons for keeping a large body of troops together, their camp is intrenched for a greater security.

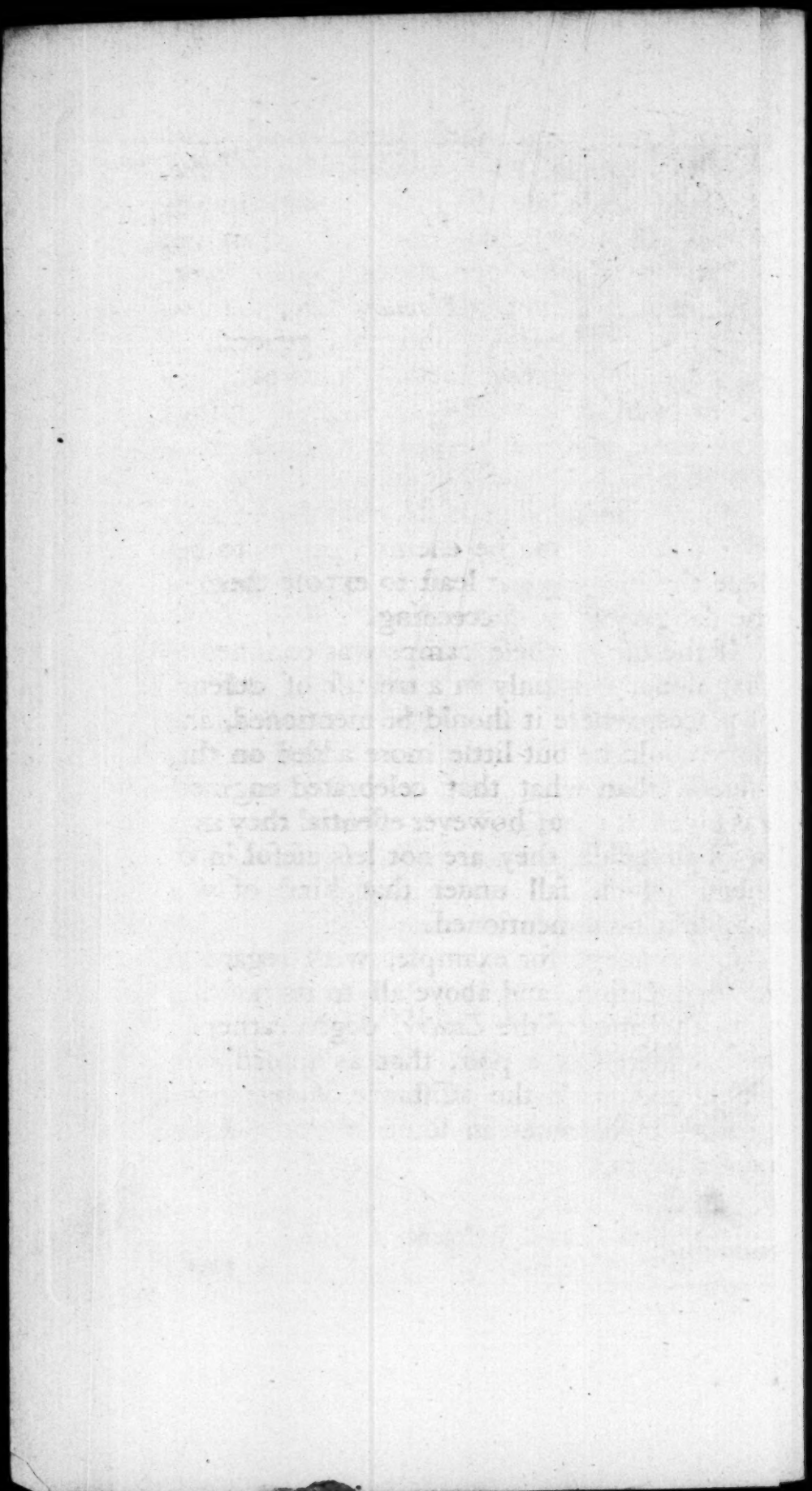
The *Greeks*, the *Romans*, and most other nations, seldom made any stay in a place, without fortifying themselves in it. The army being assembled, forms by its position a square, or some other rectangular figure of small circumference, in regard to the number; this custom seems to have been practised, till the last century; but that of encamping in one or two lines being since introduced, cannot be intrenched otherwise than by lines; but



# COMMUNICATIONS.









but it is neither of these lines, or of these transitory camps, that we shall treat of here.

These camps are of a more modern invention; I do not know even, if we are not obliged to *Vauban* for them. They were formed in his time at *Namur*, *Ath*, *Lauterbourg*, and *Dunkirk*; and this general, so good a judge of this matter, ventures to say in one of his best works (a), that he wished they were made beforehand at all the frontier places.

The principal objects he proposes by this, is to put it out of the enemy's power to besiege the place, or at least to expose them to the danger of not succeeding.

If the use of these camps was confined to that alone, it is only in a treatise of defence of places, where it should be mentioned, and there could be but little more added on that subject, than what that celebrated engineer has given us; but however essential they may be in that case, they are not less useful in others, which fall under that kind of war which is here mentioned.

*Lauterbourg*, for example, with regard to its fortification, and above all to its position with the lines of the *Loutre*, ought rather to be considered as a post, than as an ordinary place, and with the assistance of intrenchments, it becomes in some manner unattackable.

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(a) *Traite de la Defence des places.*

A town, such as *Spire*, surrounded with a bad wall, without a rampart, is in itself incapable of supporting a siege; but intrenchments being added, are sufficient to deter an enemy from attacking it.

The advantages of these camps extend yet further: an army never exposes its flanks to a considerable body of troops without danger, when this body by its extent cannot easily be kept in awe; even simple detachments do not make excursions with impunity, when their passage, and above all their retreat, is made so dangerous.

*Lauterbourg* and *Spire* can by this means, if necessary, cover the country on this side the rivers which run through them.

Lastly, Mr. *Vauban* observes, that intrenched camps serve likewise to place magazines, all kinds of stores and baggage, and to secure the adjacent country people, with their families, their effects and cattle.

II. No intrenched camp has hitherto been made but under some place, good or bad; which serves it for a retreat, or support, as necessity requires, and likewise has all necessary succours at hand; a very essential circumstance.

It is seldom that the ground adjacent to a place does not furnish some favourable situation: the ancient intrenched camp of *Dunkirk*, situated in a plain, was covered on one side by the canal of *Bourbourg*, on the other by the Canal of *Moure*, and the front defended

fended by *Fort Louis*. That of *Lauterbourg*, inaccessible in the rear, was on the side of a rising ground, at the foot of which the *Lou- tre* dividing into two branches, runs thro' a flat and marshy meadow.

Such convenient places are not found every where, but it is the engineer's business to seek for them, and to seize on all advantages. It must be observed, that these intrenchments being much less extended, and constructed more at leisure than lines, they are made much stronger; they are turfed, pallisaded, and more time and care is spent in fortifying them; by this means indeed there is therefore scarce any ground but what may be put into a good state of defence: those that are so commanded, that a motion cannot be made without being perceived, and where the parapets on that account do not afford sufficient cover, must generally be excepted. Low, marshy, unhealthful places, and where there may be a scarcity of water, ought equally to be rejected.

III. When the ground permits, the Figure of the camp should neither be triangular, nor long, but such, as that its superficies may be the largest possible, in proportion to its circumference. Of all rectangular figures, the square contains more ground in proportion to its boundary than any other, and those which come nearest to it contain more than others.



The circumference is regulated by the number of troops destined to occupy the post, or when it cannot be avoided, the number is regulated by what the Place can contain.

In either case, it is necessary to know what space must be allowed for the encampment and motions, and this cannot be known without entering into some detail; as well because of the difference of the number of men in the companies and troops that compose the battalions and squadrons, as the variations common in this case.

The front of the camp must be parallel to the intrenchment, and if possible 50 fathoms distant from it at least, that the Troops may be drawn up in order of battle, and perform their necessary evolutions.

A foot soldier's tent is 6 feet square, exclusive of the boot: 7 soldiers, or 5 soldiers and one serjeant, are allowed to a tent: the first and last face the front and rear of the camp, the rest are parallel to the front.

A company strong or weak always encamps in file, and consequently has but one tent in front. The files or companies are backed two by two, leaving an interval of a little street for the boots.

*M. Bombelle* gives 6 paces or 3 fathoms in front for the 2 files of Tents. *M. Haricourt* allows only 5 paces, which is as little as possible, the little street for the boots being thus only 3 feet.

Between

Between every 2 companies there is a great street of 16 paces, according to one of these officers, and only 6 according to the other; a like street separates the grenadiers from the battalion, whose tents are not backed by any others.

The front of a battalion is thus equal to 90 paces, or 45 fathoms; because the battalions consist of 9 companies, instead of 17, when *M. Bombelle* wrote; which shews that in encamping regard must be had to the ground that the troops take up when drawn up in order of battle.

As to the depth, *Bombelle* allows 32 paces for 11 tents, and *Haricourt* 17 for 6, which is much the same, since there is always one pace between each, without regarding the boot of the first and last.

From the last tent of the soldiers the rest are placed as follows; to the kitchens is allowed 10 paces; to the drummers and fiddlers 20; to the subalterns 35; to the captains 45; and to the field officers 80.

A *French* battalion therefore on its present establishment takes up for its camp 45 fathoms in front, and 48 fathoms 3 feet in depth; reckoning from the head of the tents; it is clear that nothing can be deducted from the first of these dimensions; but in the case we are speaking of, the three field officers are commonly in lodgings, and the other distances may be diminished; I do not see the

least inconveniency to reduce the depth to 30 fathoms.

The interval of one battalion from another is commonly 10 fathoms, and there cannot well be less. The second line is commonly 100 or 200 fathoms from the first, unless in certain cases, such as an intrenched camp, where 40 or 50 fathoms are sufficient.

The cavalry are commonly placed in the second line; each troop, like the infantry, has but one file of tents, and like them, two troops are back'd to each other. Seven paces are allowed for two of these back'd files, including the little street; three paces from the front of the tents to the piquets for the horses, which face the tents, and 12 or 15 paces from one range of piquets to another, so that the horses may have a street sufficiently wide between:

The camp of a squadron of 4 troops takes up 50 or 56 paces in front, and its depth is determined according to the number of men, allowing 7 men to a tent, and 7 paces from the pole of one tent to the next, including the quarter masters; so that every horse may have 3 feet in breadth.

At fifteen paces from the piquets are the kitchens and forges; at 25 the Sutlers; at 45 the subalterns; at 65 the captains, and 30 paces farther the field officers.

There is no interval between the squadrons of the same regiment. *M. Haricourt* allows 10 paces from one regiment to the next, 30 between



between the brigades, and 40 between the cavalry and infantry.

I do not mention the bells of arms, nor standards, tho' it is from thence we commonly reckon the front of the line; nor the quarter guards and necessary houses, because this detail is not essential to the subject in hand. However, it is right to consult all these things with the quarter-master-general, or to take the orders directly from the general.

IV. I said we never had an intrenched camp but near some town or fortress; I should indeed have excepted the following case.

The 11th of May 1734, I was sent from the army at *Bruchsal*, to *Russenheim*, a village one league above *Philippsbourg*. I there found the brigades of *Gondrin* and *Britany*, each of 4 battalions, and the regiment of dragoons of *Languedoc*, under the command of *M. de Balincour*. This place, being intended to be made a post, could not contain so many troops; it was therefore necessary to fortify the camp, which was extremely easy, as the situation was very favourable.

The plan sufficiently shews this: the ground Pla. XIII. to be occupied was higher on the flanks and rear than its environs. The right was covered by a quick hedge and bounded, as well as the village by the *Pfintz*, a little river with steep banks, where another arm and two rivulets fall into it. I observed grooves, and a free-stone flooring at the bridge, which

## FIELD

made it easy to form an inundation. Some banks could therefore easily confine the water, and raise it 8 or 10 feet from the foot of the village, to the place they empty themselves into the river; the meadows near the river were low and marshy. On the left a meadow commanded by a rising ground separated it from the *Rhine*, and the chapel being on a steep, higher ground than the rest, and covered with briars and bushes, served as a citadel.

Having by this only the front to intrench, and no want of workmen, I was resolved to spare no pains. In the evening I stopped the water to make the inundation; and after making my report to *M. de Balincour*, whose thoughts agreeing pretty well with mine, he ordered me to trace out the new camp the next day, in every respect, as in my sketch.

The fortification is very simple and plain; it is a kind of horn-work of 150 fathoms front, covered by a ravelin; the perpendicular is 20 fathoms, and the faces 40: the right branch runs parallel to a hedge which covers it; but the left, being of much greater extent, is flanked by returns at right angles, and by the chapel.

This line need not be very thick, as the returns only are exposed to cannon, because there is no probability that the enemy will engage in this confined place, where they are flanked besides by a considerable fire.

An

An engineer always works with pleasure when he is thus seconded by nature; but I was soon deprived of this satisfaction. I had scarce marked out the camp, when *M. Portal*, who commanded us, arrived. He in general approved of my scheme; He would only have the head of the bridge secured by two redouts, and to make three redans, instead of the two half bastions and to the ravelin; perhaps he had at that time designed the bastioned lines, which we soon after traced before *Philipsbourg*; however he charged another engineer with the work, and took me the next day to visit the lines on the *Loutre*, where I was in chief.

V. I do not know how this post was fortified, as I did not see it afterwards; but being confined to the figure, it was very difficult in other respects to conform to what was ordered.

We shall find in the ensuing chapter, that redans in themselves have some essential defects, by the obliquity of their defences. These defects, tho' known, do not prevent from using them to cover right lines and retring angles; as to salients, when they are right or acute, as the inconvenience increases in proportion to their acuteness, I do not know that the means of using them there has been found.

We commonly use small bastions, and in the case we are speaking of, it being impossible



possible to make demi-redans, we substitute demi-bastions.

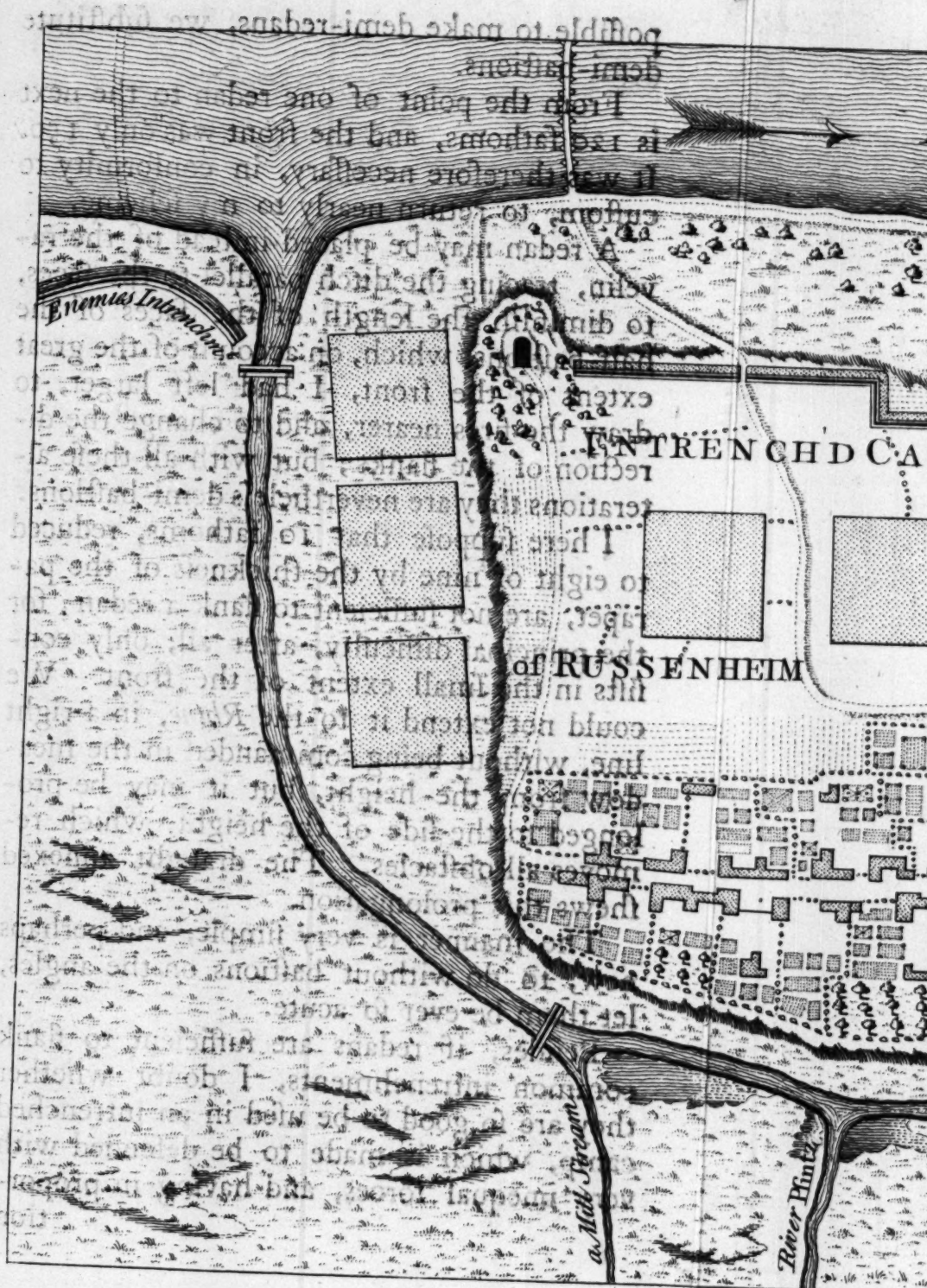
From the point of one redan to the next is 120 fathoms, and the front was only 150. It was therefore necessary, in conformity to custom, to return nearly to my scheme.

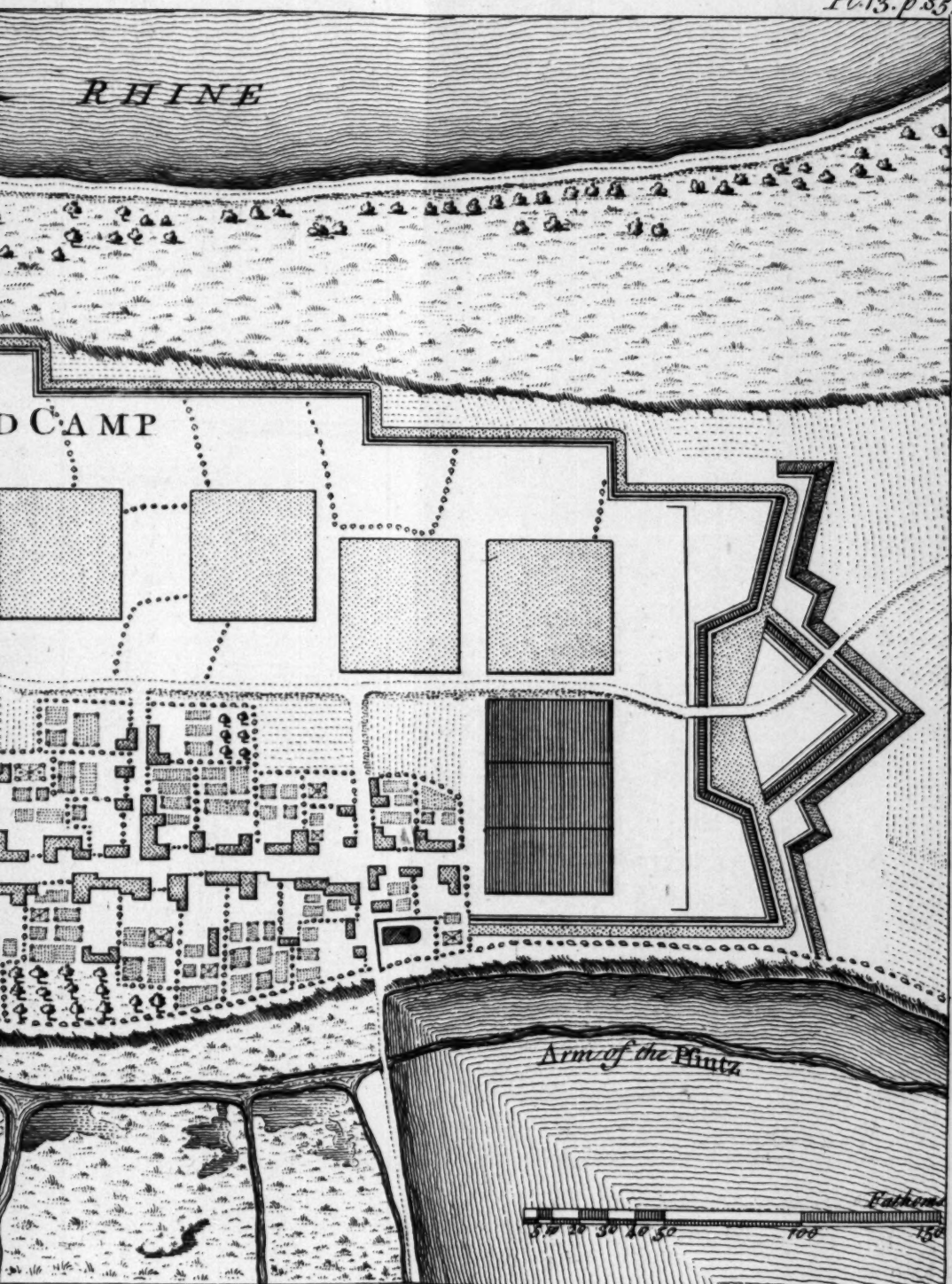
A redan may be placed instead of the ravelin, tracing the ditch parallel to the faces, to diminish the length of the faces of the half-bastions, which, on account of the great extent of the front, I had left larger, to draw the fires nearer, and to change the direction of the flanks; but with all these alterations they are nevertheless demi-bastions.

I here suppose that 10 fathoms, reduced to eight or nine by the thickness of the parapet, are not sufficient to flank a redan; for the principal difficulty, after all, only consists in the small extent of the front. We could not extend it to the *Rhine*, in a right line, without being commanded in the meadow from the height, but it may be prolonged to the side of the height, which removes all obstacles. The draught annexed shews this prolongation.

The manner is very simple, and perhaps new, to do without bastions on the angles, let them be ever so acute.

Besides, if redans are sufficient to flank common intrenchments, I doubt whether they are so good to be used in an intrenched camp, which is made to be defended with very unequal forces, and having in proportion







# ENGINEER.

non less extent, ought, when possible, to be furnished with more care.

VI. I hope it will not be thought I want to commend my first scheme; for though I think it better than the second, yet it is far from being perfect.

I here remark the defects of both; the one, which is the subject of this article, depends on the placing of the line; the other, more essential, which regards the method of fortifying it, and shall be treated of in some of the subsequent articles, and in chap. VIII.

I make it an established rule, that the head of the camp should, if possible, be at least 50 fathoms from the interior part of the intrenchment, whereas in the plan it is but 25. The camp of the dragons, reduced to 60 fathoms in front for three squadrons, is a little crowded, and besides is on the right against the branch it must defend, and its rear towards the village.

Lastly, there being only 150 fathoms from the angle of the left demi-battion to the Riviere, it may be asked, why the front is not continued to the Riviere, since that line, about two thirds shorter than that which runs towards the chapel, would inclose more ground?

To this I answer; my design was to have brought the fortification more forward, by which means the troops there, and in particular the dragons, would have had more room, but I was not master: it was thought necessary to have as little parapet to line as possible.

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I here remark the defects of forts; the one, which is the subject of this article, depends on the placing of the line; the other, more essential, which regards the method of fortifying it, and shall be treated of in some of the subsequent articles, and in chap. VIII.

I make it an established rule, that the head of the camp should, if possible, be at least 50 fathoms from the interior part of the intrenchment, whereas in the plan it is but 25. The camp of the dragoons, reduced to 69 fathoms in front for three squadrons, is a little crowded, and besides, is on the right against the branch it must defend, and its rear towards the village.

Lastly, there being only 120 fathoms from the angle of the left demi-bastion to the *Rhine*, it may be asked, why the front is not continued to the *Rhine*, since that line, about two thirds shorter than that which runs towards the chapel, would inclose more ground?

To this I answer; my design was to have brought the fortification more forward, by which means the troops there, and in particular the dragoons, would have had more room, but I was not master: it was thought necessary to have as little parapet to line as possible,

possible, and that it could not be done, but by contracting the camp.

I doubt whether these defects are here of any great consequence, I know that a common intrenched camp, or a line, should be defended by a large body of troops, drawn up in order of battle; and as it is a useful and durable work, should have room for all sorts of stores: I contest none of these reasons; but with a little reflection, it will be found, that this was not exactly the case here. For this post was properly but an intrenched village, which could not serve to keep stores, and there was no reason for keeping it long, and in effect, was abandoned long before the end of the siege of *Philipsbourg*.

As to the left branch, I might add, that I preserved by that the superiority of the ground; that, had the front been extended to the *Rhine*, I should have run the risque of being plunged from the rising ground, and this part of the intrenchment, though much shorter, required much more work than the other; besides the addition of a ravelin, it must have been constructed much stronger, to be able to resist cannon. But I honestly declare, that having only reconnoitred the ground in general, that scheme, as simple and natural as it may appear, did not strike me in the least.

VII. These replies, for the most part, appear rather excuses than reasons; which have occasioned a third plan; whose front is a crown-

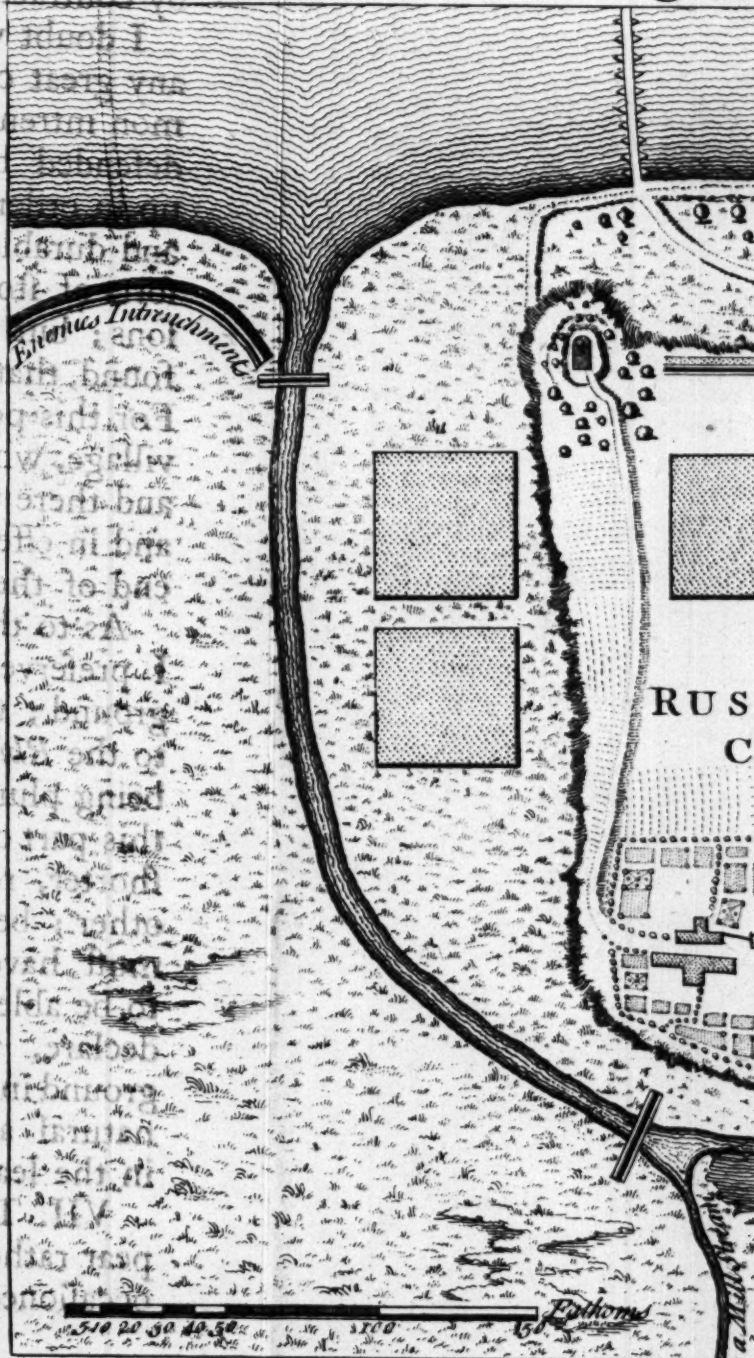


# FIELD

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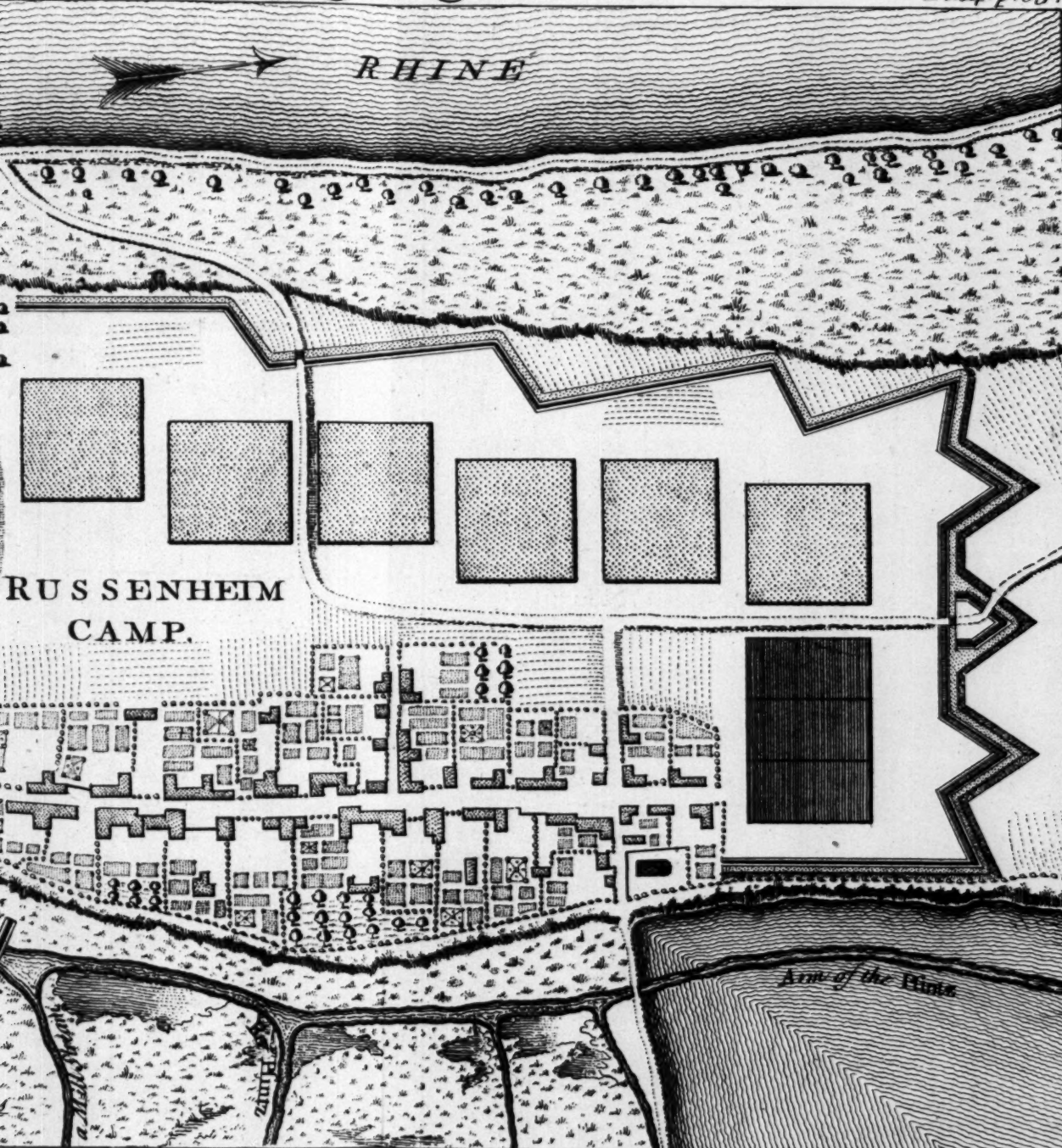
possible, and that it could not be done, but by contracting the camp. I doubt whether these details are here or any great consequence, I know that a camp is an attached camp, or a line should be by a large body of troops, drawn of battle, and as it is a useful work, should have room for all stores; I confess none of these with a little reflection, it will be found that this was not exactly the case here. The camp was properly but not extended, which could not serve to keep stores, and there was no reason for keeping a long way in effect, was abandoned long before the end of the siege of Philadelphia. As to the left branch, I mentioned that it was by that the importance of the camp, had the front been extended to the river, I should have in the mind of being changed from the rising ground, and the camp of the intrenchment, though much required much more work than the other, besides the addition of a trench, it would have been constructed much stronger, to resist cannon. But I honestly declare that having only recommended the general, that scheme, as simple and natural, as it may appear, did not make me in the least.

These replies, for the most part, are rather excuses than reasons, which have not a third plan; whose front is



# INTRENCHD CAMPS.

Pl. 14. p. 85.



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to intrench the infantry, at the nearest  
place, and have more room on their flanks  
and rear.

This new design, even reckoning the in-  
crease of theavelin, has no more extent than  
the first - it is then preferable, as it incloses  
more ground. Ten battalions and six squad-  
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a fourth less have in the other.

As to considering a body of troops are  
capable of undertaking some extraordinary  
enterprise, and it is always material to  
shorten the time they lose in filing off as much  
as possible, have placed a gate in each cur-  
tain, and one on the left, near the branch,  
which being less seen by the enemy, may  
also be considered an advantage.

VIII. The plan, only given to show how  
the inconveniences of the former may be  
avoided, is indeed exempt from them, yet  
all are defective in several material points.

We



crown-work, traced after the common method, except the flanks, which are perpendicular to the lines of defence. It does not reach beyond the high ground, to avoid being plunged, but the return of part of its branch supplies that with little expence, and without inconveniency, as it is flanked and covered by the rest. Plate XV.

The front of the camp, as in the others, is only 25 fathoms from the intrenchment, because I believe it is sufficient here; the cavalry placed as usual in the second line, are 50 fathoms from the infantry, at the nearest place, and have more room on their flanks and rear.

This new design, even reckoning the increase of the ravelin, has no more extent than the first; it is then preferable, as it incloses more ground. Ten battalions and six squadrons have here more room, than troops by a fourth less, have in the other.

As so considerable a body of troops are capable of undertaking some extraordinary enterprizes, and it is always material to shorten the time they lose in filing off as much as possible, I have placed a gate in each curtain, and one on the left, near the branch, which being less seen by the enemy, may also be esteemed an advantage.

VIII. This plan, only given to shew how the inconveniencies of the former may be avoided, is indeed exempt from them, yet all are defective in several material points.

We

We cannot attend too much to the flanks, since in them consists the principal defence: these are very large and well directed, but what advantage is reaped from them? as there is only 5 or 6 fathoms between the faces and the counterscarp for them to play upon, the rest of course fires on the ravelin.

This ravelin, necessary to cover the barrier, is more hurtful than useful: it defends the access to the faces I allow, and if we suppose a regular attac, it may be of service; but as we are here more exposed to a storm than a siege, and, as in this case, it is very dangerous to stand your ground in a detached work, the best way will be to retire with your troops, the moment of the assault, to avoid confounding your own troops with the enemy, or seeing them rush in through the barrier.

The flanks having thus their full liberty, the besiegers will be exposed to a dreadful fire, while in the ravelin: but then those opposite the faces will be the less.

These bastioned fronts have this inconvenience, the ditch is so large (in proportion to the rest) between the ravelin and the curtain, that the excavation becomes tedious, and wheel-barrows, or hand-barrows must be employed to transport the earth to the proper places. To remedy that difficulty, I practised the following scheme, in a parallel case.

IX.

IX. In *April* 1735, lieutenant general *Quadt*, ordered me to make a scheme for fortifying *Spire*, where he commanded, together with a retrenched camp. I shall speak here of this last only; the situation was very favourable, no better could be wished than that between the *Spire* back, and the new back.

This position, in regard to the place, was as convenient in large, as that of *Russenheim* in small: I made the front about 500 fathoms, it commanded, and was more extensive, than the ground by which it can be approached.

It was necessary to occupy the tower of *Spire*, by way of an advanced guard or post, by which the enemies motion can be discovered as far as the wood: but to be abandoned in case of a general attack.

A ditch of 30 feet wide, and 9 or 10 deep, runs close to this tower; this is a great obstacle, especially, for the horse to pass under the fire of cannons. The camp could not be made nearer to the town, without losing in every respect the advantage of the ground.

The right branch designed to make part of the lines, traced on the side of the river, which I had before received orders to reconnoitre, was to have been covered by an inundation. Two heights run along-side of it; I followed the lowest, not to crowd the figure, and to be nearer the water-side, it is higher than all before it by some feet.

The



The left extends along the *Neuback*, which in that place was 15 feet deep, and 9 fathoms broad, it can overflow the meadow, adjoining this branch, 4 or 5 feet high.

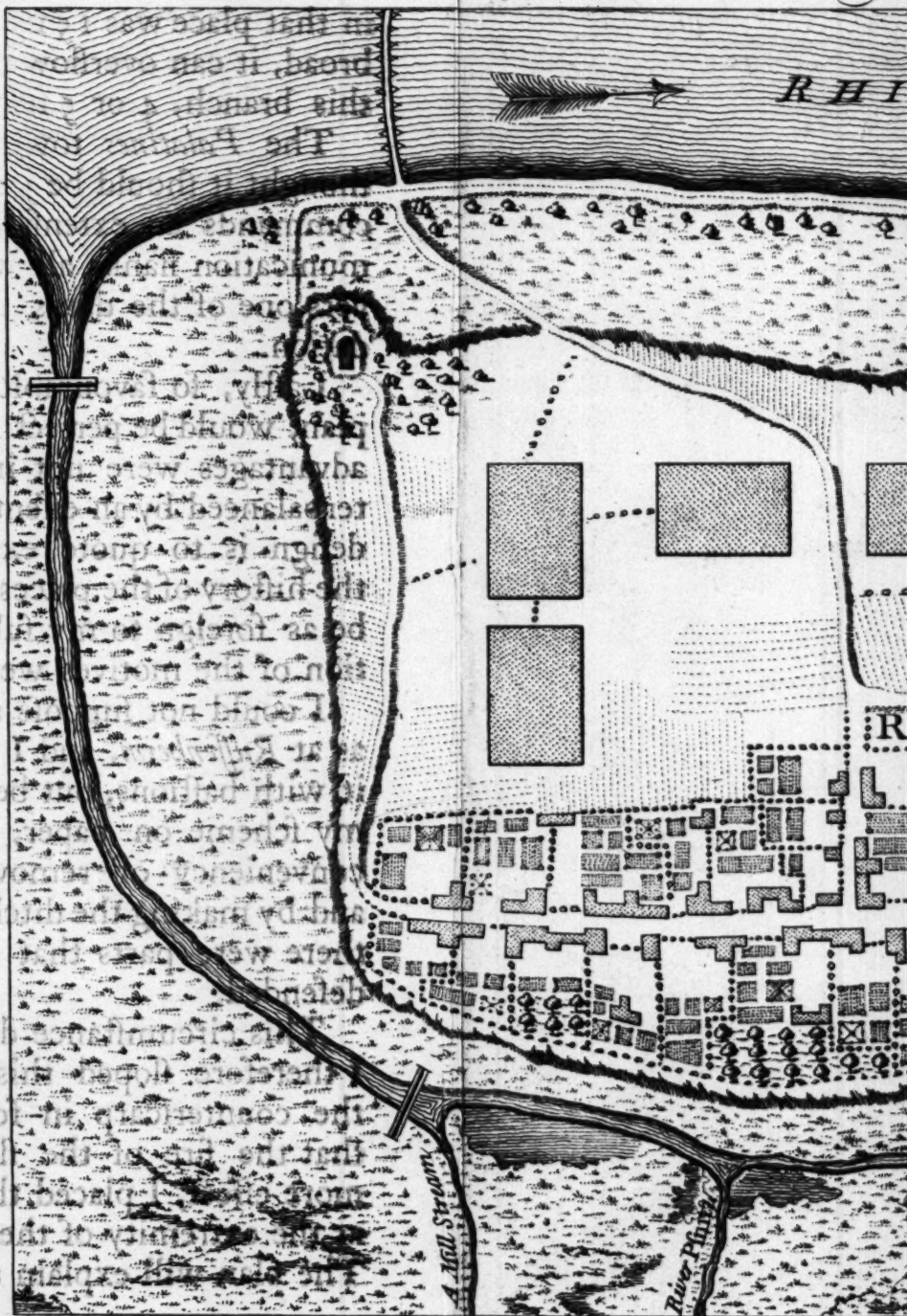
The *Palatines* tower is so near, that I thought it should be joined to the line, as it commands an extensive prospect, its communication flanks all within reach, and covers one of the dams necessary for the inundation.

Lastly, so favourable a situation, as to the plan, would be perfect in all respects, if these advantages were not in some degree counterbalanced by an essential defect; but as my design is to quote examples, and not give the history of the places, a longer detail would be as foreign to my subject, as the explanation of the motives we then had in view.

I could not suppose an attac in front only as at *Ruffenheim*, and I had resolved to make it with bastions, but being at leisure to trace my scheme on paper, I discovered the inconveniency of removing so much earth; and by making the ditch parallel to the faces; there were parts that could not be seen or defended.

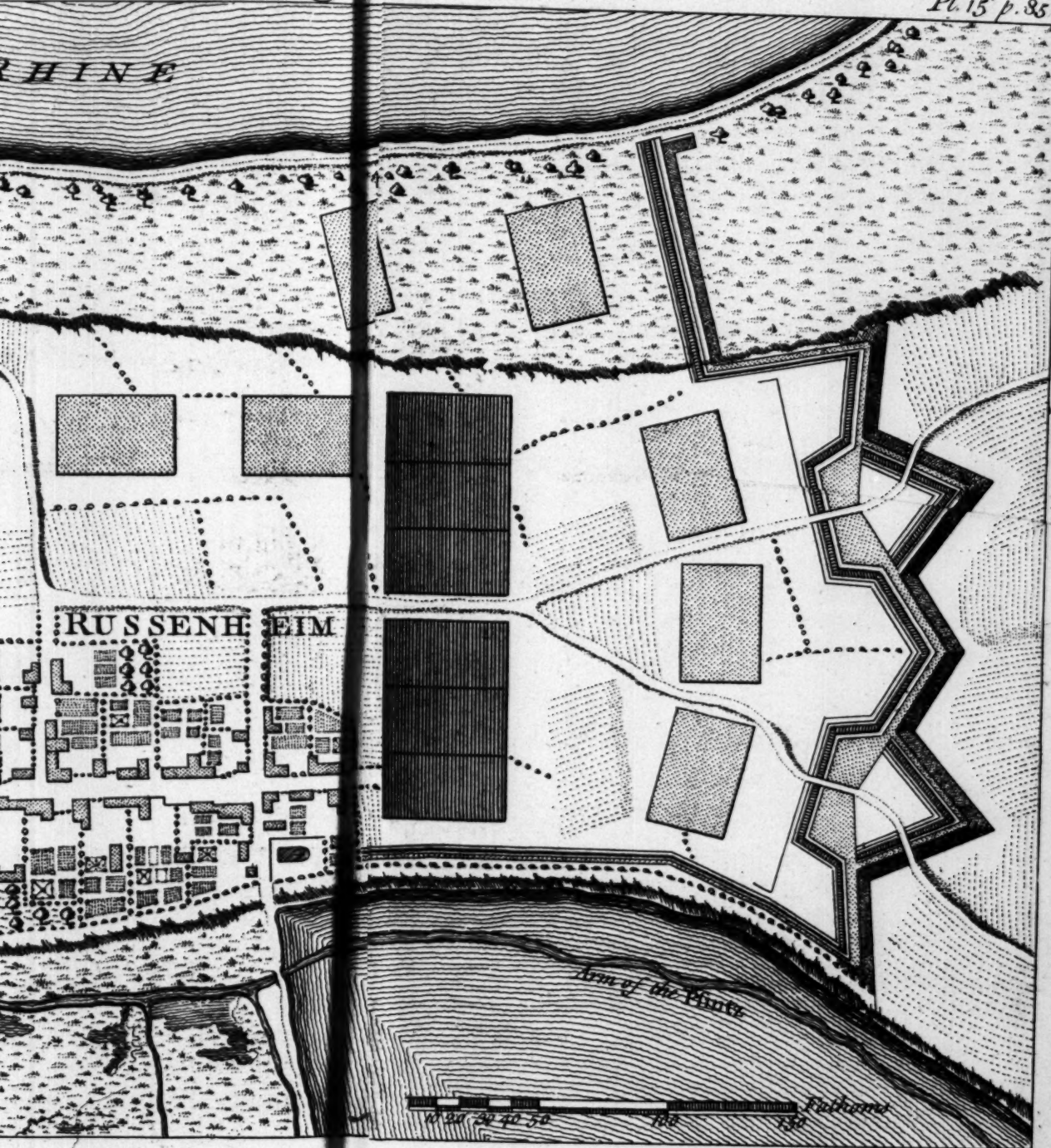
This circumstance did not discourage me; I therefore sloped this troublesome part of the counterscarp in form of a *Glacis*, and that the fire of the flanks might have the more effect, I placed the passages of the gate at the extremity of the faces of the ravelins. The plan will explain the rest: I thus corrected

The left extends



IN TRENCHD CAMP.

Pl. 15 p. 85.





## ENGINEER.

...of my passioned fronts in some measure  
...I am sensible that I only remedied one  
...of their defects. We shall treat more  
...satisfactorily on this method in chapters  
...and 11.

### OBSERVATIONS on the fifth chapter.

The author observes, that the ancients  
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such; but as the present manner is to con-  
stribute them so as the troops may be placed in  
two lines, the square form cannot be ob-  
served. I know it is a maxim of the mo-  
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der as they are to fight in, that is, in two  
lines; the foot in the middle, the horse at  
the wings, and the body of reserve behind.  
As the present manner of drawing up an  
army in order of battle may be, and has  
been conducted by men of great knowledge  
and ability, the ground will not always per-  
mit to form to great a front, nor will there  
be always found a proper situation to encamp  
in this manner. Mr. Saxe's manner of draw-  
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it requires the least work to intrench  
it.

rected my bastioned fronts in some measure, but I am sensible that I only remedied one part of their defects. We shall treat more satisfactorily on this method in chapters 7 and 11.

OBSERVATIONS on the fifth chapter.

The author observes, that the ancients formed their camps into squares, or nearly such; but as the present manner is to contrive them so as the troops may be placed in two lines, the square form cannot be observed. I know it is a maxim of the moderns, to encamp the troops in the same order as they are to fight in, that is, in two lines; the foot in the middle, the horse at the wings, and the body of reserve behind. As the present manner of drawing up an army in order of battle may be, and has been contested by men of great knowledge and ability; the ground will not always permit to form so great a front; nor will there be always found a proper situation to incamp in this manner. M. Saxe's manner of drawing up an army is a sufficient proof, that the modern custom is not so advantageous as many may imagine. It is therefore the situation of the ground that ought to determine the manner in which an army ought to be drawn up, or to incamp; when the ground is convenient, they should form a square camp; because it requires the least work to intrench it,

it, as we have shewn in a former observation. In doing this I can see no inconvenience to form any line of battle whatsoever: for I suppose, that as soon as a camp is formed, the ground for drawing up the army is pitched upon before the camp, and the order of the troops to march out determined: and in case the enemy should attempt to force the camp, no better form can be pitched upon to defend it than the square one.

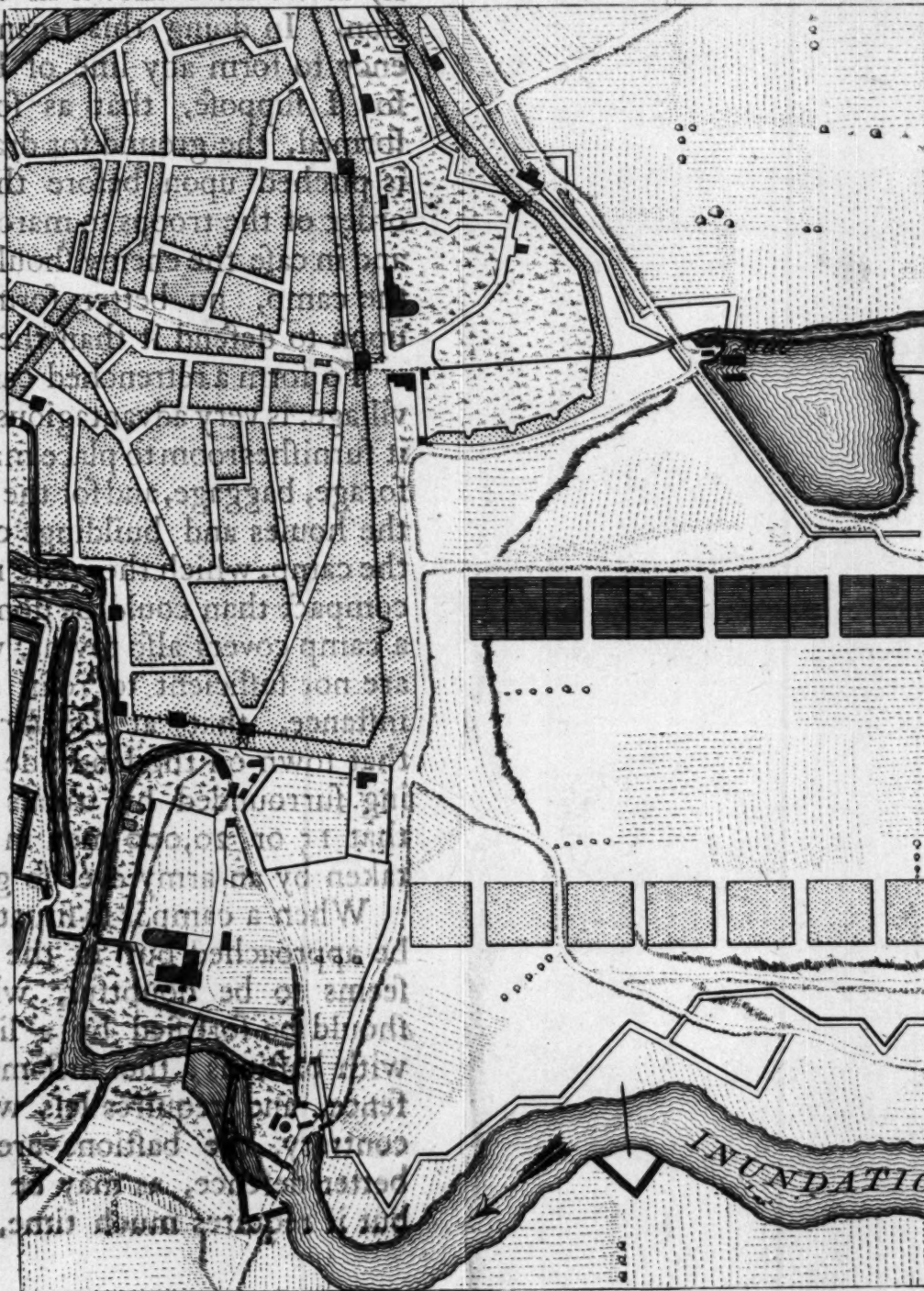
To form a retrenched camp near a town or village, is very advantagious in many respects; it furnishes room to place magazines for stores, forage, baggage, and for the sick and wounded; the houses and buildings cover the flanks of the camp, which therefore may be made more compact than could be done otherwise. Such a camp covers also towns, when fortifications are not sufficient to resist an army. As for instance, that at *Dunkirk*, which covers that town on the land side; its situation being surrounded by canals and inundations, that 15 or 20,000 men in it, could not be taken by an army ever so great.

When a camp is so situated, as cannot well be approached but in the front, the author seems to be doubtful, whether that front should be fortified by a line with redans or with bastions; the first manner has less defence, and requires less work; and on the contrary, the bastions are able to make a better defence, as may be seen in Plate 15; but it requires much time, and a great deal  
of



## FIELD

A detailed black and white illustration of a landscape, likely a river or stream flowing through a wooded area. The foreground shows a path or road leading towards the water. The background features dense trees and foliage. The style is reminiscent of a woodcut or engraving.



# 4<sup>th</sup> INTRENCHD CAMP of SPIRE

50 100 200 Fathom







of labour to remove the earth out of that part of the ditch before the curtains; and tho' the flanks are large and well disposed, yet as the ditch before the faces is but narrow, and the ravelin so close, they can make but a very small defence. I wonder that an author, of so much experience as Mr. *Clairac*, should commit so many mistakes, before he could find out the manner of correcting this inconveniency. He was sensible, that a front with bastions was much preferable to one with redans, in all other respects excepting the want of room for the fire from the flanks to extend as far as it should. There need not have been occasion for so many examples as he has given to see; that by removing the ravelins a little farther from the curtain, and to slope the ditches of the faces near the shoulders, it would remove that defect.

The author says, that the space each regiment takes up in a camp must be known before the retrenchment can be made; but as the particulars he gives relate to the *French* army, which are different in ours, we shall give here such as are necessary to be known upon such occasions.

The depth of a foot regiment incamped, consisting of 9 companies, each of 100 men, computed from the serjeants tents to the rear, is 200 yards, and the front 245, including the battalion guns. But if the regiment consists of 9 companies, 70 men each, the depth

H

is

is likewise 200 yards as before, but the front is only 150, including the battalion guns.

The front of a regiment of dragoons incamped, consisting of six troops, forming three squadrons, with the light troops, takes up 200 yards, and the depth 258: the interval between two regiments of foot or dragoons is 60 yards. The particulars of the foot and horse camps are foreign to our purpose; but those who are desirous to know more of this matter, may consult the military discipline, published by J. Millan, where they will find plans, &c. of the present incampments for horse and foot.

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## CHAPTER THE SIXTH.

- I. *Different uses of lines.* II. *Objections and answers to those that cover an army.* III. *Those that cover a country.* IV. *Those that are designed for a new system of a defensive war.* V. *Necessity of supporting the extremities of these lines, and how.* VI. *Distance of lines, from heads of camps.* VII. *Defects of common lines.* VIII. *Means of correcting them.*

I. **T**HE use of lines may be divided into different classes; the one proper to hinder succours, or to curb the enterprises of a large and active garrison during a siege, concerns the attac of places only, and consequently does not belong to our subject.

The

## ENGINEER.

99

The other, which few authors have mentioned, regards the rendering an army formidable in a retrenched camp; to prevent the enemy's excursions, by opposing an impenetrable barrier; or lastly, to secure an army, so as to keep upon the defensive with safety, if thought necessary. Though an engineer is seldom acquainted with the general's designs, even in this case; yet, as he ought not to form any scheme without being able to answer any objections that may be made against his works; we shall begin to examine here the different opinions, commonly alledged for and against these different kinds of retrenchments.

II. To supply by art the defect of a bad situation, necessarily to be occupied, stands to reason; wherefore to fortify the camp of an army cannot, by any shew of reason, be blamed, provided the works are not too extensive, are well directed, and so disposed, that the army may conveniently make any motion upon occasion.

These conditions which include the whole, leave scarce room for any objections; but their execution is not always easy. Suppose there are reasons that an army should keep upon the defensive, and avoid an engagement; it is necessary to find either an inaccessible camp, or a post which can be attacked no where else but in a front well fortified in every part. There is I believe no other alternative; yet this may not pre-



vent our applying the following words of M. Feuquieres, which in fact are as applicable here as to lines of the third kind. *An intrenched army, says he, cannot sally out but by a small front; and consequently the enemy in his approach, being free in all his motions, may make them as hazardous as he pleases, without fearing the least inconveniency: I conclude, that an army which is straitened in all its motions is always inferior to another, tho' equal in number, which can move with an entire liberty, and may run any risk with impunity.*

This maxim is worthy of its author; I have already declared that the application may be just; but being unable to hurt an enemy, is only an inconveniency to which we may oppose the grand motive *necessity*, which according to our supposition obliges us to attempt every thing to avoid an engagement. M. Feuquieres is also so far from blaming this practice, that he says, there are examples of batteries being raised, and even trenches opened in form, to force an enemy from their intrenchments, thrown up for want of a good situation; an enterprise which, in his own words, "always supposes a great superiority in the assailants, and even a necessity of coming to action, which is ever attended with a great loss of men."

If there are no reasons for avoiding an action, but only to balance the superiority of numbers by fortification, then some detached works, whose quantity and strength, determined

terminated by this inequality and situation, may be sufficient, whence the preceding objection has no weight : but are there no others ? “ Nothing enervates the courage so much,” says the ingenious \* author in the preface to a new system of fortification, “ as to think one’s self on the defensive ; because it is very natural to reason thus ; I defend myself, consequently then I am in danger, or rather I am the weakest ; but an idea of danger, and a knowledge of weakness, disheartens the most brave.”

This is true, speaking in general, and we see the consequence that may be drawn from it, even in the case we are now treating of ; but is it always in a general’s power not to be on the defensive ? and so far is fortification from being a discouraging testimony of our weakness, that we may regard it as a remedy to supply its defects ? “ The shovel and the Pick-axe, says M. Folard, speaking of this kind of war, are the resource of the weakest, or of those that would not hazard an action ; they are the only arms by which they defend themselves, and the best to hinder the effects of others.”

III. Lines, of the second kind, fall under the same objections, and are even more exposed to censure. Their principal design is to defend the country they cover from contributions ; to have it in their power to raise

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\* *Le Pere Castel, Jesuite.*

them; to preserve a communication from one place to another, without the necessity of escorts; and to render these places not liable to be attacked, as long as they subsist.

M. *Feuquieres* pretends, that all these advantages, except the last, are not real; or are counterbalanced by great inconveniences; he thus explains himself.

“ Experience, says he, has frequently convinced us, that these lines do not hinder  
 “ a country from paying contributions, since  
 “ to establish it there needs only an opportunity of forcing them once, during the  
 “ whole course of a war; after which, tho’  
 “ the troops that forced the lines should be  
 “ obliged suddenly to retire, the contribution has been demanded; and in a treaty  
 “ of peace, if made with any equality, they  
 “ must be accountable for the sum imposed,  
 “ tho’ not raised; thus lines are of no use  
 “ in guarding a country from contribution.

“ The second reason, viz. that of establishing contributions in an enemy’s country does not hold good. It is not the  
 “ parties that sally from lines, but those  
 “ from fortified places, that levy them.

“ That of facilitating a communication  
 “ from one place to another, continues he,  
 “ is somewhat more apparent, for those who  
 “ would go without escort under cover of  
 “ these lines; but if it is for the security of  
 “ convoys, then that facility is only apparent; for if a prince reckons what the  
 “ con-



“ construction and maintenance of these lines  
 “ costs him, and the quantity of troops they  
 “ require for their defence, I am thoroughly  
 “ persuaded, that he would find these troops  
 “ more usefully employed in guarding places,  
 “ escorting convoys, and with the army,  
 “ than in guarding these lines.”

I have before observed, that this author says nothing against that essential advantage, of preventing places surrounded by these intrenchments from being invested.

Such an authority is without doubt respectable; but these maxims seem to be advanced in a very general manner. There are lucky situations, such among others, are those from *Bergues* to *Dunkirk*, and from the mountain to *Lauterbourg*, which being carefully fortified, would prevent their being forced or penetrated by a small body of men ever so bold; therefore such lines would prevent contributions being raised.

They have also the means of imposing contributions; for it is not clear, why a party falling from thence have not the same privilege in that respect, as others.

Lastly, if as in the first case, such lines join to fortified places, these places become unattackable; and if, as in the other, they join to an enclosed town, but little fortified, it cannot well be supported, but by such assistance. I agree that this cannot be on the *Loutre* without a certain number of troops; but are they entirely lost there? no, since

they cover all lower *Alsace*, they keep in awe, and even distress a body of troops, at least equal to them, unless the enemy abandons all the country before them.

The lines from *Bergues* to *Dunkirk* have this further advantage, that even in the presence of an enemy, the garrisons of these places, and the adjacent posts, may be sufficient to guard, or at least to defend them.

Will not every one agree, that it is much better to do without an escort, than be obliged to take one, were it for no other reason but that they may be beat?

To all these objections, M. *Feuquieres* had added, that of the expence, which he says, exceeds what the contribution will come to: this can but very seldom be true; but besides other advantages which may be drawn from them, we must add, that of depriving the enemy of that contribution, which they otherwise could make, either in money, subsistence, or labour.

IV. The kind of lines, M. *Feuquieres* most briskly attacks are those, which according to him, have of late years established a new system of defensive war. "Experience, says he, has shewn the falsity of this system, which consists in two incontestable points."

The first is that we mentioned of armies enclosed and confined in intrenchments. An army (adds he) in lines, is never compact, because it must defend a great front, and consequently when surprized in one part,

“ part, either thro’ the nature of the country, or the night, which may conceal the enemy’s march, it is certain this attac can only be supported by one part of the army; for the rest cannot march to their assistance where the real attac is, but with great difficulty and in column, which is dangerous.”

He afterwards remarks, that these lines being greatly extended, and constructed with the view already mentioned, must greatly weaken an army to guard them; in consequence of which they have been forced every time they have been attacked; and besides, their excessive extent preventing their being sufficiently furnished with redans and other works, they cannot be good; that is, they cannot be fortified with sufficient care.

I shall not take upon me to answer these objections, so solid in themselves, while they only regard ordinary cases; I agree, that as to their extent, simple intrenchments of four or five leagues are not sufficiently fortified to secure an army tho’ equal in number from being exposed; but supposing a favourable situation, these lines do not much differ from the second kind; we may therefore alledge in their favour, what we have said of the others.

The lines of the *Loutre* (a) for example, are

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(a) These lines are the same as those of *Villembourg*, which



are more than five leagues long ; yet if they were in the state they might be put in, with less than two months work, 20,000 men could defend them with success, against the most numerous army.

It is true, they have one of these conditions which *Feuquieres* afterwards demands, viz. to reduce the enemy to certain places of attack, and it will be difficult, even to find any but one that is practicable ; and though they are long, yet they support as well the only bad place found in them, as they are also supported by it.

I believe then we may conclude, that as there is not any kind of lines, to which we cannot make solid objections, so there are none from which we cannot draw great advantages, when art is seconded by nature ; I say seconded by nature, for if they can be flanked and enfiladed, it is plain they are of no advantage. I am convinced, and shall always think, that lines raised in dry, even and open ground, such as a vast plain, are more dangerous than useful, when their extent is more than the front of an army would occupy in battle. As to intrenched camps, we know that *Feuquieres* did not find the attack so easy, which is equal to an approbation ; *Folard* and *Santa Cruz* speak of them,

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which *Feuquieres* mentions in his remarks ; I do not know that they have been either forced, or abandoned since 1706, when taking the advantage of the ground they were covered by inundations.

the

the first as a *practice of the antients, which we have left off, for another much less advantageous, namely, that of grand guards, posts and detachments in front; the other as the best means of easing the troops; to be capable of making great detachments; and not to engage but when it is thought to advantage, and not when the enemy pleases.*

V. The chief attention in planning lines, is, as was before observed, to support the extremities, so that they neither can be flanked, nor the enemy attempt it.

This precaution is the more or less necessary, according to the use these lines are designed for: if they must cover a whole country, as those of the *Loutre*, a vast and thick forest, which is yet better for being marshy; a chain of mountains with narrow passes, which are easy to be defended; a broad and deep river, or any such objects, are of great advantage.

These advantages are absolutely necessary in this respect, for they are no guard against incursions without them, and such intrenchments, being mostly of a very great extent, in proportion to the number of troops that guard them, they are almost only supported by the goodness of their fortification; so that the enemy might not have time to flank them, before their too weak and much dispersed defenders have time to collect themselves to make them repent of such a movement, even if they were strong enough for such an enterprize.

These

These positions, both favourable and indispensable, are scarce, I agree, but such lines ought to be seldom used: as to those designed only to cover an army, which will not come to action but with that advantage, a fortified place, a town enclosed with walls, a country castle, a little wood that may be filled with infantry, a morass known to be impracticable, a river with deep banks, or muddy, are sufficient: these may yet be supplied, as we have seen, by covering the flank by an intrenchment with redans, or by felling.

There are even examples that a general, not content with these precautions, has intrenched himself in the rear, and thus shut himself up on all sides, which forms a new kind of intrenched camp, fortified according to the nature of the ground; but these examples are not common.

VI. If in tracing lines we are obliged, at least in the principal parts, to follow a camp already fixed, which sometimes happens, or that some village must be enclosed, which is not so rare, it is equally necessary for an engineer to know what space should be between the intrenchment and the front of the troops.

At *Philipsbourg*; for lines of circumvallation not differing materially from these, but in their circular figure, what is agreeable to one is so to others; at *Philipsbourg*, I say, this distance was fixed at about 65 fathoms; and more was not left between the intrenchment



ment and the village of *Oberhausen*, though there were troops encamped between them; but it must be observed, that this distance is contracted as much as possible, the better to unite the forces.

*M. Vauban*, in his treatise on sieges, has fixed this distance at 110, or 120 fathoms; this he afterwards extends from 60 to 120, in his treatise on the attack of places: it may be dangerous to give more or less; for in the first case, the troops will be too far from what they are to defend; and in the second they will not have sufficient room to move in, and to leave a passage in their rear, for a body of troops to march wherever its assistance may be wanted, to support a part giving way, or too hard pressed: I believe then we may determine this distance (unless in particular cases) from 80 to 100 fathoms.

As to the parts opposite the villages, it is necessary, in my opinion, to add the depth of the camp to this distance, if the depth does not exceed 60 or 80 fathoms, counting from the bells of arms, or standards, to the subalterns tents, or to the kitchens at least, included.

VII. All lines may be fortified in the same manner, not excepting those of circumvallation and countervallation, for they only differ from the rest in their use.

The common and almost universal method is to flank them by redans. In open ground, for those of circumvallation, *M. de Vauban* allows

Pl. XVII.

Fig. 1.

allows 120 fathoms, from the point of one redan to that of the next; 30 fathoms for the gorge, and 22 for the capital; which makes the faces about 27 fathoms: it was in this manner we traced those at *Kell* in 1733, and nine years afterwards at *Nider-Alteich* in *Bavaria*.

The flanked angle of these little works is 68 degrees 34 minutes, which is open enough; but supposing the lines of fire to square on the faces, as their angle with the curtain is 34 degrees 17 minutes, they pass more than 30 fathoms before the middle of the curtain, and do not cross the capital of the opposite redan but at 49 or 50 fathoms from the point.

It must be further observed, that supposing, as we generally do, the range of a musket 120 fathoms, the collateral fires, so far from crossing on the capital, leave more than 7 fathoms between the two nearest.

From hence then, reckoning the range of shot as before, and supposing also that the soldier fires directly before him, each curtain forms the base of an *Isosceles* triangle from 30 to 31 fathoms perpendicular, which is not flanked, and before each redan there is a space of 30 fathoms broad, communicated to another of the same breadth, by a passage of 11 or 12 fathoms, which is not raked from any part; this will be better understood by the plan annexed: lastly, the ditches have

have so oblique a defence, that it is evidently of very little effect.

From the freedom with which I explain myself, I hope it will not be thought I attempt the critic; it is a title that would as ill become me as I detest it: I quote and examine with sincerity; let the judicious reader decide: in a word, my own instruction, and that of my brother officers, is, as I think I have already declared, the only motive I propose in discussions of this nature.

So far from entirely rejecting a method adopted by so great a master, and so universally received, I readily allow it is sufficient, if we suppose a large train of artillery; in effect, the most of these inconveniencies disappear by this means; cannon commonly placed in the redans, make its principal and almost only defence, and not firing at random as small arms do, the obliquity of the faces is not so great a defect.

We may yet alledge in favour of this method, that a front of 120 fathoms has only 144 of parapet, that is, one fifth more; which is an advantage, especially when we are distressed for time, want of workmen, or have few troops for the extent of the parapet we ought to line; yet these advantages do not balance the defect of the oblique fires; and spaces not raked by any fire which we are commonly obliged to have in most field-forts, should be regarded as very essential defects,



defects, and even inexcusable in all cases where they may be avoided.

VIII. After this declaration, or rather repetition, I think I may advance my own thoughts; experience has often convinced us, that a moderate genius is sometimes capable of adding, and even perfecting the discoveries of a great man; if the reader knew how thoroughly I was convinced of this maxim, I should have no reason to fear being suspected of presumption.

I have remarked four principal defects in the common method, and shall here mention them.

1st, The middle of the curtain is not flanked, but at 30 fathoms distance in front.

2d, The direction of the nearest fire does not cut the capital, but at about 50 fathoms from the flanked angle.

3d, The lines of defence being more than 120 fathoms, the fire which exceeds that distance may be esteemed as nothing.

4th, The great obliquity of the redan with the curtain hinders the ditch from being defended.

I greatly mistake; or a very little alteration will remedy the whole.

Pl. XVII. It is only to brake the curtain in the middle, so that the saliant angle shall be on a line with the points of the redans, an operation as plain, as easy in practice.

The angle of the face, with the demi-curtain, being only 98 degrees 14 minutes, the

the parts reciprocally defend each other every where at a proper distance by a cross fire, and the ditches are also defended: the middle of a straight curtain, which we never attac by choice, does not here collect all the fires; they are thus distributed more equally, and even trebled towards the saliant angles, which are the weakest parts.

I cannot here pass by one reflection, so just and evident, that I regard it as a maxim. The quantity of fire that can be drawn from any work, let us do all we can, is determined by the greatness of the extent; it is then only required to distribute it equally, or in proportion as the several parts require; which I think is here done.

Let us see at what rate we gain these advantages. The front being always supposed of 120 fathoms, has 154 of parapet, that is 10 more than the common method; I ought also to remark, that the reentrant angle will not be seen, whereas it was discovered, at least obliquely from part of the opposite face. The connoisseurs may judge of the importance of this inconveniency, of which I shall speak more at large in chap. 13.

#### OBSERVATIONS on the sixth Chapter.

The manner of making lines, securing posts, and of intrenching the camp of an army, is what is here considered; also the reasons for and against this practice; it is a  
I question

question amongst military authors, whether an army retrenched, or covered by a line, should receive the enemy in them, or march out and meet him. Many examples are given in favour of the one and the other : but as this is too general a question, it would be ridiculous to say that what ought to be done on any particular occasion, must also serve on any other : the only way to decide the question properly is then to come to such particulars, as will enable us to judge, with some degree of certainty, when and when not the lines should be defended. When the intrenchment is very extensive, such as circumvallation lines, and the troops have not an open or easy communication with one another, or else are confined in their motions, it is very dangerous to wait for an enemy in them, altho' he is much inferior in number ; because he makes his approaches in the night, alarms the whole line by several false attacks, to cover or conceal the real one : whereby every part of the line must be guarded alike ; and one part may be carried, before any troops can be sent to reinforce those who are attacked. Thus the point being carried in one place, the defenders fall into confusion, are so disheartened as to give all over for lost, and retreat wherever they can. Many examples prove what has been here said ; for instance, prince *Eugene* with 18,000 men drove the *French* out of their



their lines before *Turin*, although they were 72,000 strong.

But when a general is obliged to be upon the defensive, because the enemy is superior in number, and in the goodness of troops; or to guard a pass that leads into a country he is to defend; it requires no great skill to know, whether he should retrench himself in an advantageous post or not. If a general intends to engage the enemy, but not without having the advantage of the ground, he will naturally pitch upon such a situation, where his flanks and rear are secure, either by the nature of the ground, or by works that are to be made. As to the front, he will either secure it with a good retrenchment, leaving proper openings, so as he may march out in a large front, or else make several steps, for the infantry to march over the parapet in order of battle, and openings for the horse only to march out. Sometimes the front is secured by raising redouts at proper distances, with artillery placed in them; or if villages are in the front, they are to be retrenched, and lined with troops and artillery. This M. *Saxe* did at *Fontenoy*; where that village stood in the middle of the front, *Anthoin* on one wing, and the woods of *Barry* on the other; the wood was covered with felling of trees, and had a redout in it, and the villages covered by parapets and batteries. But when no convenient posts are to be found in the front, redouts are made,

as the *Russians* did at *Pultowa* against the *Swedes*; altho' the last took some of the redoubts, yet the great loss they sustained from their fire was the occasion of losing the battle.

If it is found necessary to guard a pass, or a particular post against a superior enemy, a good intrenchment is then highly necessary; but this cannot be done without a favourable situation, so as the accessible part may be well guarded and defended, otherwise the enemy might form several attacks, both in front and flank, with a superior number. But if there be only one accessible part, and that well retrenched, tho' the enemy should force them by their superiority, yet as this cannot be done without the loss of a great many men, the advantage will be on the side of the defenders, provided they can retire with safety. Consequently the retrenching an army is, generally speaking, advantageous, and often absolutely necessary.

The chief objections of authors against a retrenched camp are, that the army in it is confined in its motions, and cannot come out but in a small front; whereas the enemy, being at liberty, may hazard his motions as much as he pleases, without any danger of suffering by it, and attac either in one place or other. As to the first, it is supposed the army has sufficient room for moving with ease to what part they find it necessary;

fary; and as to the second, the works may be so contrived, either to march over the parapet in order of battle, as we have mentioned already, or to leave proper openings from distance to distance, sufficient to march out in large bodies: and to prevent the enemy from availing themselves of these openings, a traverse is raised inwards, so as to cover them against the enemy's cannon, or to prevent them from forcing their way thro' them: and for a greater security cannon may be placed on each side to flank them, which being loaded with grape shot, will soon make them tired of their attac.

Intrenchments or lines are made likewise to cover a place indifferently fortified, and which sometimes contains the principal magazines of an army, or to cover a considerable extent of ground, to prevent an enemy from entering into the country to raise contributions. Sometimes an army is obliged to retire before a superior or victorious enemy; in such a case, by intrenching itself near a town or village, for the sake of quarters for the sick and wounded, or to form new magazines, becomes necessary, provided the place cannot be attacked but on that side; an old wall, or a strong building to place men and artillery may be of great use. This is the case at *Dunkirk*, which has an intrenched camp on the land side, surrounded by canals and marshes, and may contain 25 or 30000 men very conveniently. This



camp covers the town entirely, which might otherwise be attacked by a small army. Lines have been made in many places of several miles long, generally covered, in part by large rivers, and from one fortified place to another; but their defence becomes very precarious, excepting the attack can be reduced to certain places; for sometimes they have been forced with very little difficulty; and at others, tho' the enemy has penetrated them, yet has been obliged to retire without being able to effect his design. The advantages of those lines depend on proper situations, the difficulties of penetrating them undiscovered, and on the capacity of the general who defends them; so that nothing certain can be said for and against such lines, without being upon the spot to see what can be done to secure them.

The different figures given to lines or intrenchments require particular considerations. For if an army is already incamped, the engineer must make his works conformable to the situation, and take care to have sufficient room between the line and the front of the camp, for the army to draw up in order of battle, in case of an attack; the rising grounds within cannon-shot must be occupied either by the line itself, or by some detached works, whose communication with the line is secure; or if a river is at hand to form an inundation, so as the enemy cannot possibly drain it: in short, all advantages possible

fible must be taken that the ground can afford ; which requires more skill and knowledge than is generally imagined ; and is therefore not to be found, but in an engineer of the first rank. As there is no situation, but what is stronger by nature in one part than in another, it is therefore necessary to fortify the weak part so much more, as to make its approach of the same difficulty as the others.

When a post has some natural advantages, the common lines with redans, at 120 fathoms distance (such as fig. 1. plate 17.) will be sufficient ; but to such parts as can be approached without any natural obstacle, such a line is not sufficient. Sometimes the same sort of lines are used, with two or three ditches before them, and the intermediate spaces are made full of round holes 7 or 8 feet deep, with stakes drove in the middle, as may be seen in the third plate of my attack and defence of places ; and sometimes these lines are covered with detached works, such as redouts and lunettes. Our author proposes two different manners of making lines stronger than the first, as may be seen in fig. 2, 3. plate 17. they however differ only in the length of the branches, which form the salient angle.

The author lays down as a maxim, that the quantity of fire or defence that can possibly be had from a work, is always in proportion to it's extent ; and therefore, it re-

mains only to distribute the fire equally every where, or proportionally to the exigency which some parts require, one more than another: this is undoubtedly true, in general, not only in lines, but in all fortifications whatsoever; but then this maxim cannot always be observed; for sometimes the figure of a line is so determined by the nature of the ground, as not to be changed for a better, without falling into some considerable mistakes. Suppose, for instance, a river passes before the camp, it's windings must be followed, otherwise an enemy might pass it, where it is farthest distant from the line; or, suppose a bank, or rising ground, it is plain the slope must be followed every where, or else the enemy may approach under cover; in these places, which cannot be flanked by the line, in short, general maxims ought to be followed, when no other obstacle intervenes; and consequently, an expert engineer will chuse, amongst the various disadvantages, those that can be easiest remedied.



## CHAPTER THE SEVENTH.

I. *New schemes of lines, with redans.* II. *With Tenailles.* III. *More perfect.* IV. *With indented work.* V. *With redans and lunettes, their inconvenienty.* VI. *With tenailles, and lunettes.* VII. *With broken tenailles and lunettes.*

I. **T**HE alteration of the forementioned fires of the curtain produce another very considerable, which is that each front, being sufficient for its defence, becomes in a manner a whole front; I will explain myself better.

The front of a fortification, with regard to the defence, is a collection of lines, contrived so as reciprocally to flank each other; but according to the common method, the curtain only fires right before, and the two faces which terminate it, are the only parts that have, or are designed to have, this property, the front cannot be complete, that is flanked throughout, if it is not composed of the curtain and two faces.

In the new plan, if the face defends the demi-curtain, it is also equally defended by it; so that supposing these parts were detached from the rest, and that they cannot be attacked in the rear, they will be capable of supporting themselves.

From

Pl. XVII.

Fig. 3.

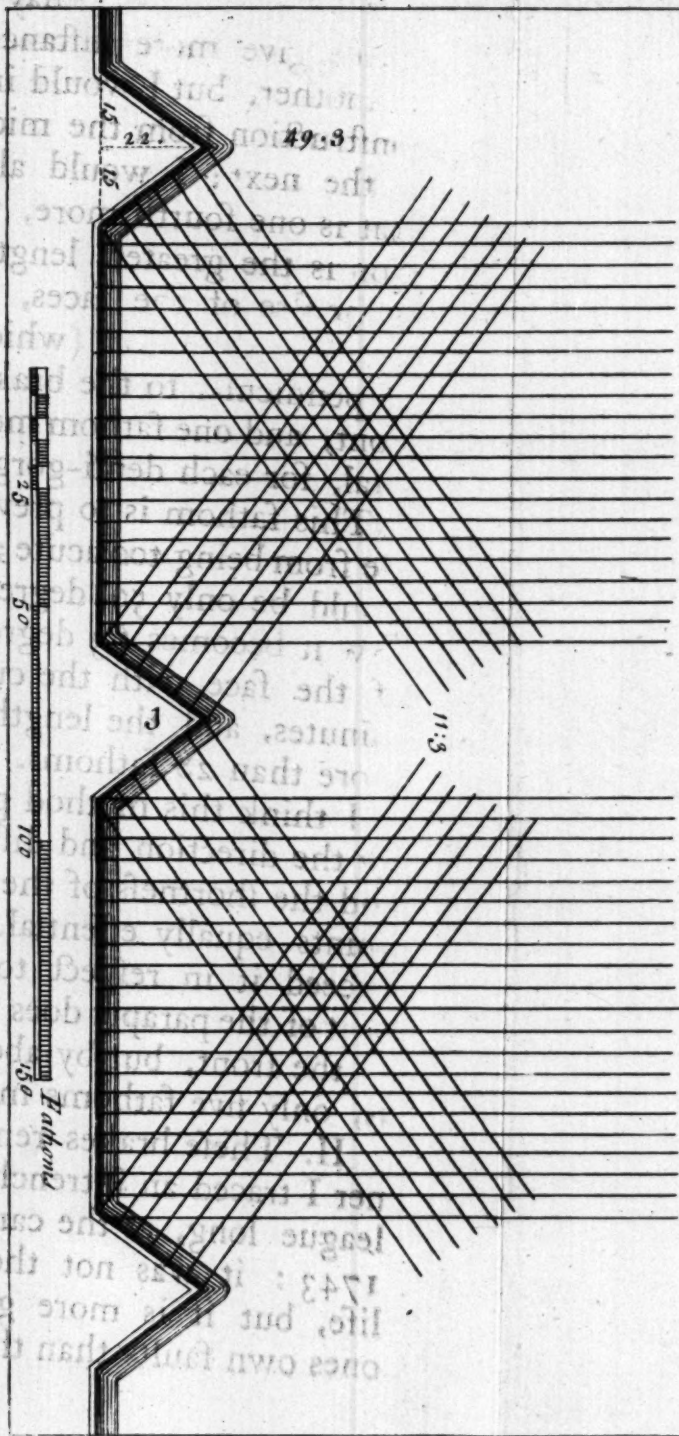
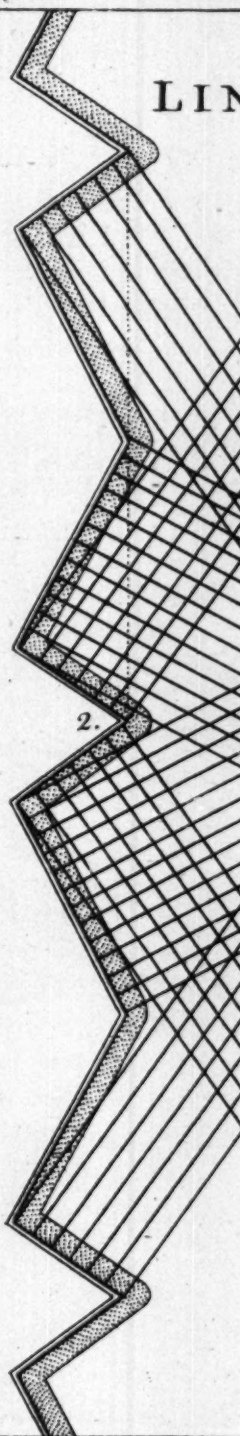
From thence, we may without inconvenience give more distance from one redan to another, but I would in this case alter the construction from the middle of one to that of the next; I would allow 150 fathoms, that is one fourth more, which in my opinion is the greatest length to be given: as to the fire of the faces, I would make the capital of the redan (which also serves as a perpendicular to the brake) one fifth of the front, and one fathom more than half the capital, for each demi-gorge.

This fathom is to prevent the flanked angle from being too acute; which, without it, would be only 59 degrees 22 minutes; and now it becomes 63 degrees 24 minutes, that of the face with the curtain 99 degrees 54 minutes, and the length of the face will be more than 28 fathoms.

I think this method preferable to the old, by the direction and distribution of the fires, and the shortness of the lines of defence, all points equally essential. It does not much exceed it in respect to work, since the extent of the parapet does not exceed the length of the front, but by about 35 fathoms, that is, only five fathoms more than one fifth.

II. These brakes remind me of the manner I traced an intrenchment of about half a league long, at the camp under *Landau*, in 1743: it was not the best I made in my life, but it is more generous to point out ones own faults than those of others; I need not

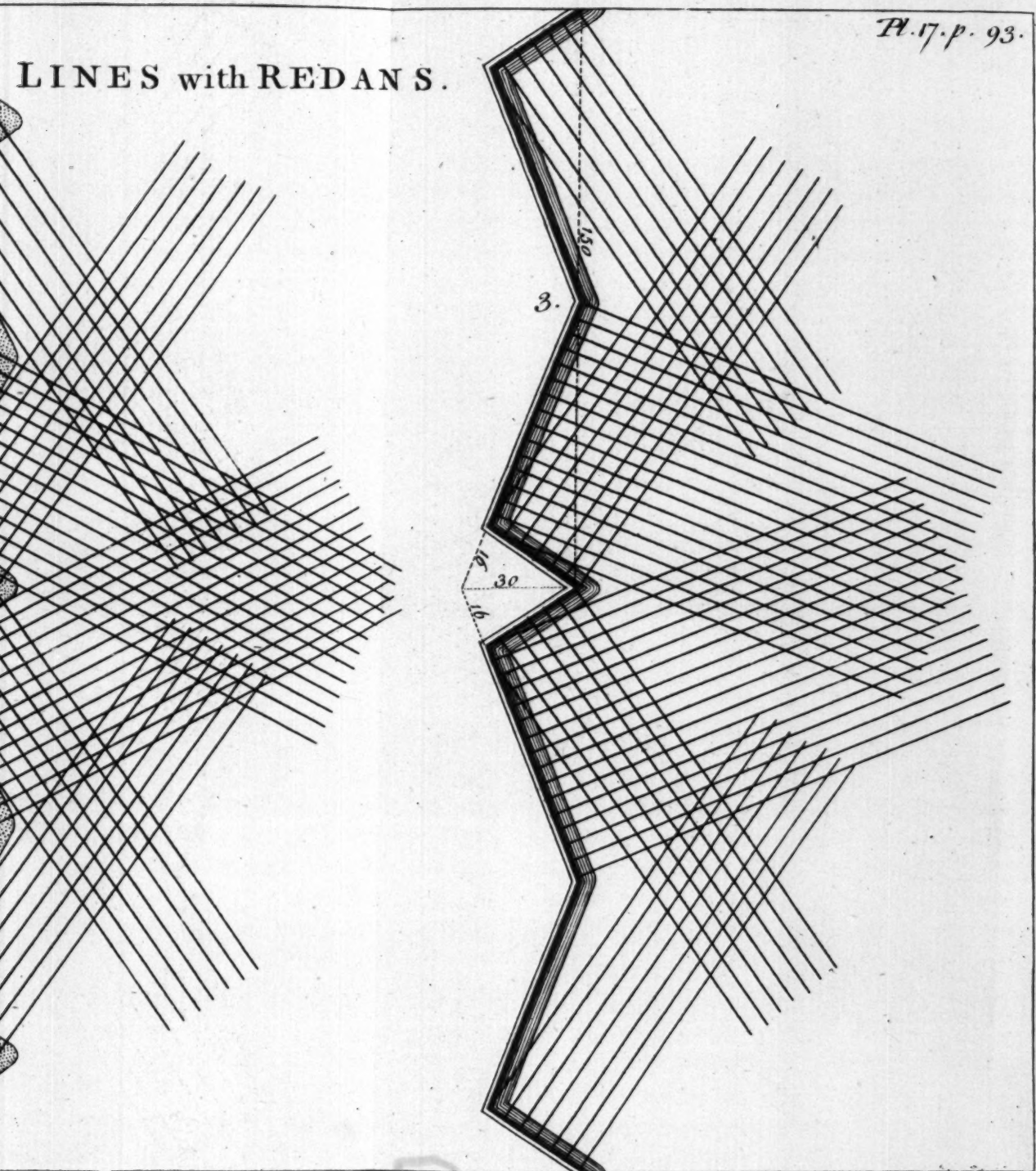
LIN



1710



LINES with REDAN S.



# COINTE

... being suspected of magnifying the  
 ... embarras ...  
 ... of expositions.

I was willing to follow, as much as I  
 could, the line of a bank, about two  
 right that the meadow, my scheme was  
 to bring the river, & into the angle  
 received my orders on the spot, and  
 be traced out immediately.

It struck me to make it in form of a  
 ... or swallow tails, which appeared  
 ... having fewer salient angles, and  
 ... being very obtuse, were in no  
 ... being washed away by the water.  
 As to the fortification, I knew that the  
 perpendicular of two lines, which formed a  
 ... crossed each other, ...  
 ... reflection, and fixing each from  
 ... the work was quickly pick-  
 ... what I allowed for the per-  
 ... but suppose about one fourth of  
 ... on this supposition I will ...

The ... and ... angles by this  
 ... 22 minutes, consequently  
 ... of the nearest ... supposed to  
 ... an angle of 30 degrees 22 mi-  
 ... the branch it should flank 20  
 ... by this obliquity there must be 14 fa-  
 ... it does not touch the capital,  
 ... it long enough, it would  
 ... 30 fathoms from the salient  
 ...

not fear being suspected of magnifying them, and one is less embarrassed for the turn and choice of expressions.

I was willing to follow, as much as I could, the side of a bank, about two feet higher than the meadow, my scheme was also to bring the river *Quiech* into the ditch. I received my orders on the spot, and it was to be traced out immediately.

It struck me to make it in form of plain <sup>PL. XVIII.</sup> *Tenailles*, or swallow tails, which appeared <sup>Fig. 1.</sup> the best, having fewer saliant angles, and these saliants being very obtuse, were in no danger of being washed away by the water.

As to the fortification, I knew that the perpendiculars of two lines, which formed a reentrant angle, crossed each other: I made no farther reflection, and fixing each front at 120 fathoms, the work was quickly picketed out; I forgot what I allowed for the perpendicular; but suppose about one fourth of the front, and on this supposition I will examine my plan.

The saliant and reentrant angles by this were 126 degrees 52 minutes, consequently the direction of the nearest fire, supposed to square, forms an angle of 36 degrees 52 minutes, with the branch it should flank; so that by this obliquity there must be 14 fathoms, where it does not touch the capital, and even supposing it long enough, it would cut it at about 90 fathoms from the saliant angle.

I fell



I fell then into all the faults I have found in the common lines with redans, (except that of the curtain) without gaining any thing more than 10 fathoms of extent by the *Tenaille*, and being less liable to be hurt by the current of the water: for giving 8 fathoms more to the perpendiculars, than what is allowed to the capitals of the redans, it is plain I was farther distant, at least in the reentrants, from the edge of the bank I wanted to follow.

If the disposition had not been changed, which hindered the execution, I should not, I believe, have been the last to have perceived, that it would not have answered my intent; yet I should have discovered it too late. How came it about? because I had not time to trace my plan on paper, to examine the direction and range of the fires; a confused notion of the reentrant deceived me; I rejected the common method, designing to give some lines of better effect, and I made them worse, or at least very indifferently.

The same cause has, and will often produce the same effects. On these occasions, we have seldom leisure to draw out our plans, which would be a great advantage. A number of maxims, examples, analyses, &c. in this science, would supply that defect; but how are they to be obtained? we do not study this subject in fortified places, because the object is not before us, and there are no books

books that treat of it. As to what we see in time of war, fatigue, different applications, and various other causes, often hinder our examining them so minutely as to gain any knowledge by them: besides, whatever affinity there may be between field fortification and that of places, the last is not sufficiently clear to explain what belongs to the former.

III. I experienced, as may be seen, what I have advanced; for if I had better known the properties of the *Tenailles*, or had time to examine them with my compasses in my hand, these faults could not have escaped me; I should readily have found out from whence they proceeded, and perceived that to have remedied them, I need only to have shortened the front, and diminished the opening of the angles. Pl. XVIII. Fig. 2.

I use both these means in the second plan. The front is but 100 fathoms, and the perpendicular the third of the front: the line of defence makes an angle of 22 degrees 38 minutes, with the branch it should flank, and it cuts the capital at  $41\frac{1}{2}$  fathoms from the salient angle, so that the columns of fire of each front, after reciprocally crossing each other, cross also on a considerable part of one of those angles, with one of the columns of the next front.

The extent of this figure, as in common lines, is only one fifth more than the right line. I leave the reader to compare the other advantages of these methods, and shall only

only add, that this plan would much less have answered my scheme of keeping close to the side of the bank, than that I designed, as the length of the perpendiculars would consequently have obliged me to retreat farther from it.

IV. Indented works, such as I made use of in the second intrenched camp of *Russenheim*, may also form a new kind of lines; we shall examine their construction, and the effect we may expect from them.

Pl. XIX. Divide the whole front into parts of 60 fathoms each; let fall a perpendicular from each of these points, of one fourth of that measure, that is, of 15 fathoms; draw the branch from the foot of one perpendicular to the summit of the next; advance 5 fathoms, on the foot of the branch, for the part that is to flank that branch.

The angle of the flank, with the branch, will only be 91 degrees 21 minutes, so that the line of defence will pass but 5 or 6 fathoms from the adjacent flank'd angle, and as that will only be near half the range of the shot, it will cover the angle of the next branch opposite the flank.

Thus there being no part that is not defended by two preceding flanks, the length of these flanks, which is no more than 14 or 15 fathoms, appear to me sufficient.

These columns of fire, following each other, and doubling towards the middle of their range, have an uncommon effect, which  
is



# AI TEN with LINES

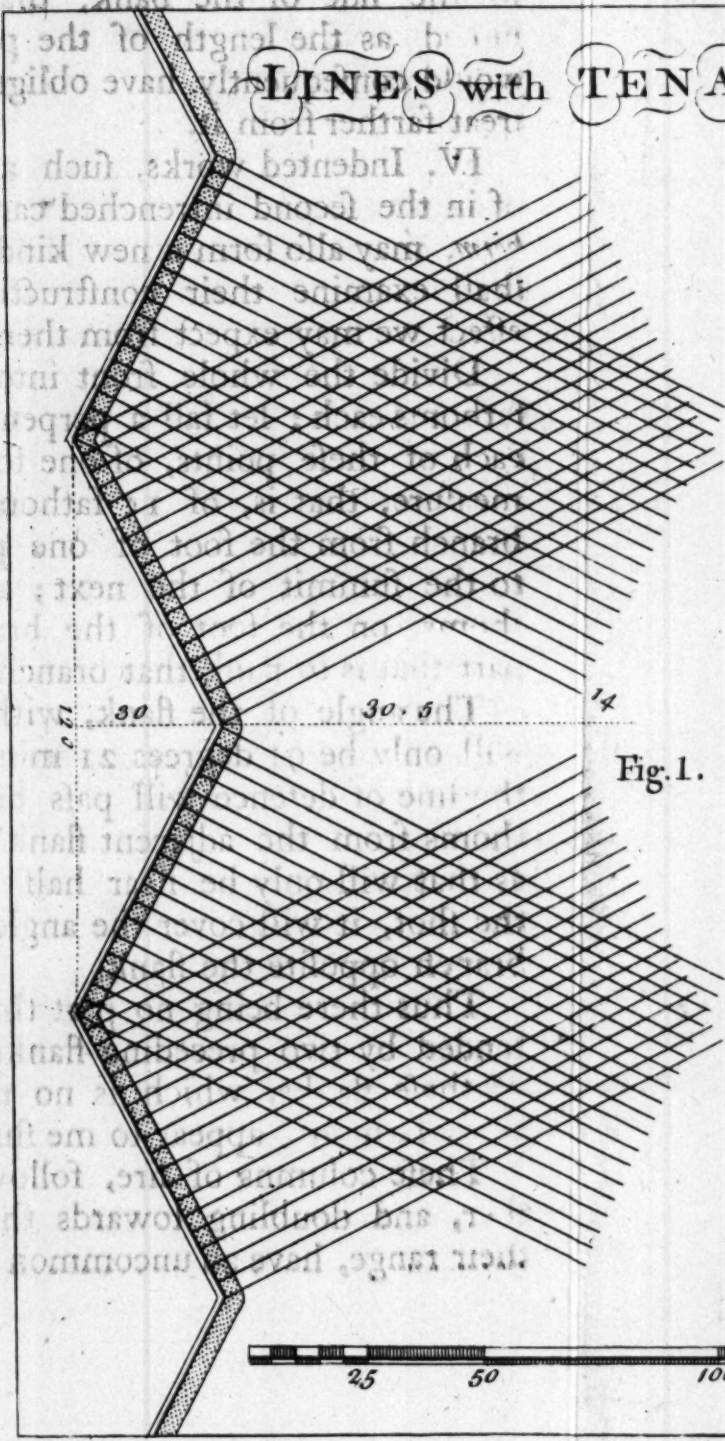


Fig.1.

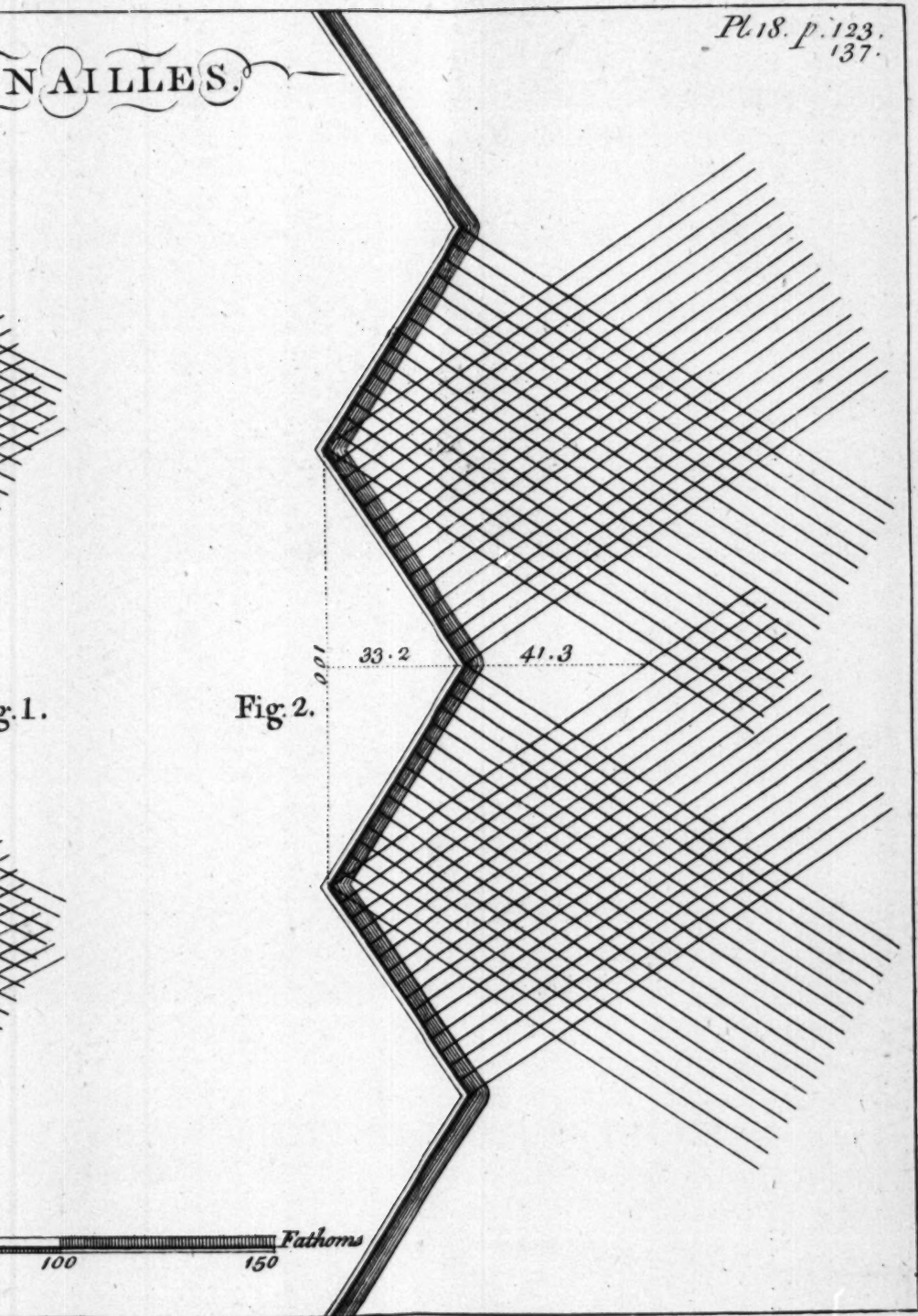
NAILLES.

Pl 18. p. 123.  
137.

Fig. 1.

Fig. 2.

100 150 Fathoms



as it must  
a distant defence begins to weaken,  
necessity to procure a second nearer.  
We may also reckon among the advantages  
of this scheme, that the salient angles do  
not in number to the common method, and  
ranked at half market-shot, advancing ver-  
ticle into the country, are less exposed to  
the enemy; that on account of these in-  
jections, and the shortness of the branch  
it is easy to follow a determined line, and  
keep all advantages of the configuration  
the ground; that it is the only plan, in which  
direct fire runs parallel throughout an  
without interruption, and the only one  
which the trees are equally distributed.  
That these incidents may in this man-  
ner, I believe, it will be better, for  
reasons I shall give. To dispose them other-  
wise, is to form a salient angle by  
branches, equal to the others, at every  
point, which salient angle must be flanked  
by two redoubts, and that each extremity  
is terminated by a battery.  
I would fix the middle of the gorge of  
the position as a point from the point of  
the extremity of the branch falls on the line  
of flanks I would elevate the same way, at  
the same distance the flanks of the redoubts  
down a line from one shoulder to the  
other, on the middle of which line eleva-  
tion perpendicular to one of these pa-



is still greater, as it must be allowed, that when a distant defence begins to weaken, it is necessary to procure a second nearer.

We may also reckon among the advantages of this scheme, that the saliant angles double in number to the common method, and flanked at half musket-shot, advancing very little into the country, are less exposed to the enemy; that on account of these small projections, and the shortness of the branches, it is easy to follow a determined line, and to reap all advantages of the configuration of the ground; that it is the only plan, in which a direct fire runs parallel throughout and without interruption, and the only one, in which the fires are equally distributed.

Tho' these indents may in this manner be continued from one end of a line to the other, I believe it will be better, for the reasons I shall give. To dispose them otherwise, so as to form a saliant angle by two branches, equal to the others, at every 400 fathoms, which saliant angle must be flanked by two redans, and that each extremity be terminated by a bastion.

I would fix the middle of the gorge of the bastion 20 fathoms from the point where the extremity of the branch falls on the line; its flanks I would elevate the same way, and of the same size as the flanks of the redans; then draw a line from one shoulder to the other, on the middle of which line elevate a perpendicular equal to one of these parts,  
and

and the extremity will be the point of the flanked angle, which thus will always be a right one.

The advantage I here propose, is to draw from the flanks of the bastion the same fire from small arms, as from the others, and from the face, where I propose artillery, a fire which crossing in front, should serve as the first defence to the line.

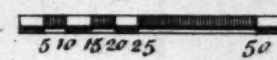
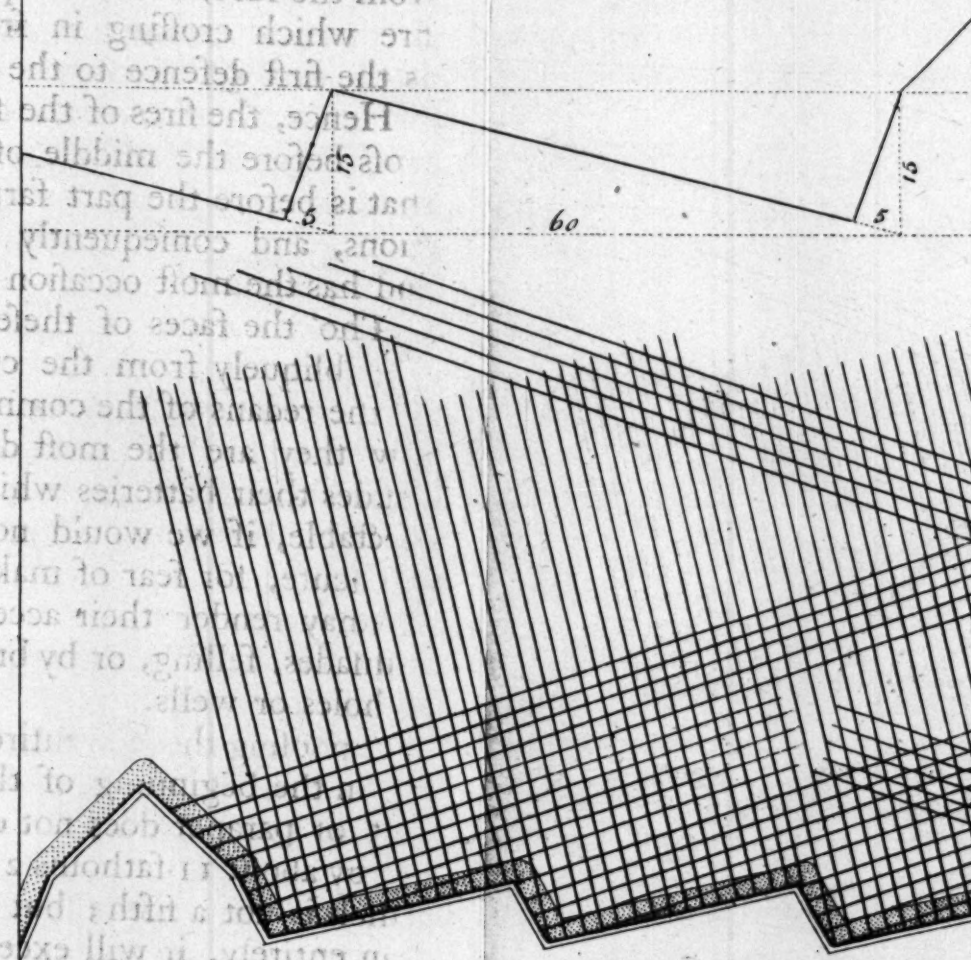
Hence, the fires of the four adjacent flanks cross before the middle of the 400 fathoms, that is before the part farthest from the bastions, and consequently from the artillery, and has the most occasion for this assistance.

Tho' the faces of these bastions are seen less obliquely from the curtain, than those of the redans of the common method, I allow they are the most defective parts; but besides their batteries which render them respectable, if we would not make the angle too acute, for fear of making them too long, we may render their access very difficult by pallisades, felling, or by breaking the ground in holes or wells.

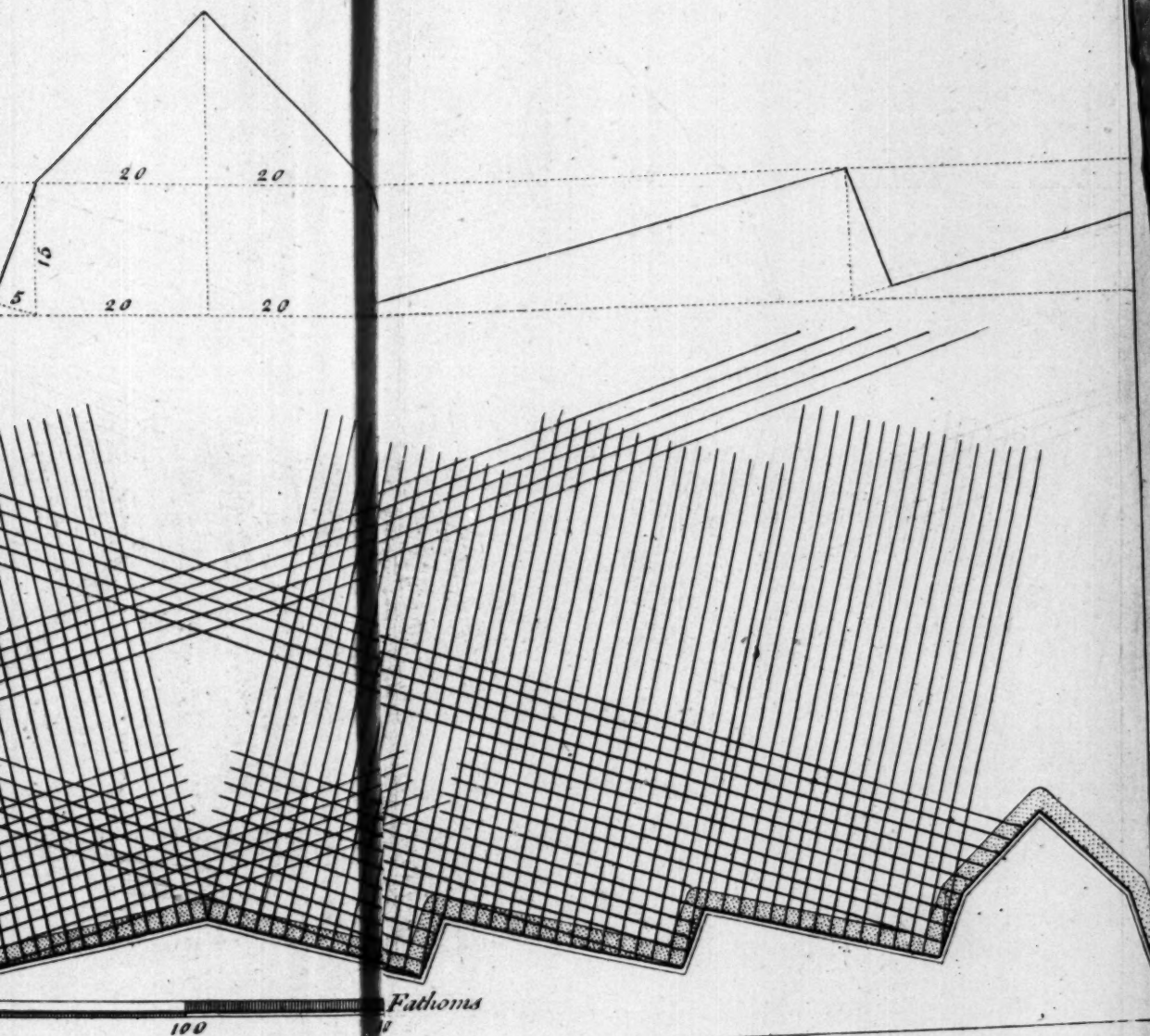
Supposing the line entirely indented, as we did in the beginning of this article, the extent of parapet does not exceed a right line, but by about 11 fathoms 2 feet in 60 fathoms, which is not a fifth; but if we follow this plan entirely, it will exceed between 84 and 85 fathoms in the front of 400.

I own these lines please me much, were it only because the repetition of the flanks,  
by

will be... which thus...  
 one...  
 the advantage I here propose is to...  
 on the flanks of the battery the...  
 from small arms as from the...  
 from the face, where I propose...  
 the which crossing in front...  
 the first defence to the line...  
 Hence the fires of the four...  
 observe the middle of the...  
 that is before the part farthest...  
 ions, and consequently from the...  
 and has the most occasion for this...  
 the faces of these batteries are...  
 wholly from the centre than the...  
 the centre of the common method...  
 they are the most defence...  
 and that batteries which...  
 especially if we would not...  
 for fear of making them...  
 their access very...  
 or by pressing the...  
 which...  
 of this...  
 does not exceed a...  
 a battery is...  
 if we follow...  
 it will extend between...  
 an entirely...  
 batteries in the front of...  
 own these lines...  
 only because the... of the...







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by their proximity, double the defence, and render it more effectual. But must further observe, that the artillery being, by its position, out of the line, it may if necessary graze it, or very nearly; an advantage which none of the beforementioned methods have.

There are circumstances where works are inclosed in the line, to favour the rallying of the troops, if needful: to effect this, it is sufficient to detach the bastions, and intrench them at the gorge, but they must be constructed with a strong profile, and surrounded with pallisades, or wells sunk in the ground.

V. What M. *Folard* proposes in his excellent commentaries on *Polybius*, may give an idea of a quite different construction to the preceding one, tho' the intent of the author was only to strengthen his fortifications by an augmentation of works. "It must be observed, says he, above all things to make advanced redouts, or arrows, at every 30 or 40 fathoms, and their communications ought to be between two banks or parapets, well pallisaded on all sides, and so, that four men may march a-breast, or in front, between the two banquets."

It could be wished, that so learned an author had entered into a greater detail on this subject, or at least had given a plan of his scheme; but all that can be concluded from thence with certainty is, that he supposes lines with redans traced in the common manner; and from thence we may judge

K  
of



of the advantages and disadvantages of his scheme.

Pla. XX.

Fig. 1.

We must then suppose a lunette advanced 30 or 40 fathoms before the curtain of one of these fronts; for it is before the curtain he places them: what is the consequence? that all, or nearly all the fire of the adjacent flanks, enfilades the gorge, or fires obliquely on the faces. I here suppose, that this distance of 30 or 40 fathoms is taken from the gorge, and not from the flanked angle of the work, or else the lunette, scarcely projecting beyond the salient angles, would not have the intended use.

Pla. XX.

Fig. 2.

With regard to the common method, if redans are so obtuse, that the lunettes may be defended and not battered, from whence are these redans and the curtain to be flanked?

It is true, the communications fire upon the whole faces of the adjacent redans, in either case; and if such works are made before all the fronts, the rest of the fire will defend the ground, before the communications next to them: this fire is certainly more dangerous to the enemy than to the defenders; yet nothing is more incommodious than to be exposed to it.

It may therefore, I believe, be concluded, that these lunettes, tho' good in themselves, cannot possibly be used with lines traced after the common method.

Permit me to make one digression, it shall be short, and the example of the author I  
quoted

quoted authorizes me. An officer who can talk well of war in general, if he is not an engineer, has not the same force of argument, when he comes to touch on any part of fortification; which equally confirms me in what I have before quoted, *viz.* that it is very dangerous to advance any thing on these subjects, that we have not proved by scale and compass; and that it is only from the body of engineers itself, that we must expect any instructions.

But to return to the lunettes. I think all the effect we may expect from these pieces, and especially from their communications, so proper to command in the rear, may be obtained, by finding a method of using them without any inconvenience.

VI. The whole then consists in flanking their faces, and directing these different fires, so that they may not be hurtful to the other parts.

These faces have no other protection to afford each other, than a fire greatly advanced before them: they are at too great a distance from each other to obtain a grazing defence, therefore it is not from thence we must expect what we seek for.

One line only, whatever inclination we <sup>Pla. XX:</sup> may give it, cannot flank the lunette and the <sup>Fig. 3.</sup> intrenchment: were we not convinced of the dangers, and small effect of defences badly directed, or very oblique, we could not deny that the directions of these fires are too

scattering to part from one and the same point.

Since then one flank alone is not sufficient, let us endeavour to obtain two. Cut the front (supposed of 120 fathoms) into two equal parts by a perpendicular; give 35 fathoms to the brake of the branches; 18 to the demi-gorge of the redan, and 25 to the capital: to construct the lunettes, set off 60 fathoms, on the perpendicular produced beyond its intersection with the front line; draw the faces of 25 fathoms long, and so as when produced meet the branches within 20 fathoms from their salient angles.

The capital of the lunette will thus be cut by the line of fire, at a little more than three fathoms from the flanked angle; so that this piece will be defended on each side by 20 fathoms, and the branch of the intrenchment by 22 fathoms, of a fire almost grazing, which is all that can be desired.

There remains only the communication to trace; and it certainly is not the most easy part. The enemy cannot there be well discovered but in front, by a part equal to its breadth: besides, if it is raised too much, it is evident it will mask the fire of the branches, and if it is sunk, it will not command enough, and be plunged into from the ground without.

To guard as much as possible from these inconveniencies, I give only 15 feet for the passage at the gorge of the lunette, and increase



crease it to 30 where it meets the front line.

By this obliquity I hinder the fire from grazing too near the saliant angles of the retrenchment, and have the advantage of opposing an enemy, when entered by the opposite extremity, with a front more than double theirs; but as it is an angle, and consequently cannot afford all the fire necessary, I would raise a traverse sloped in a *glacis*, at the beginning of the communication, and make little branches on each side parallel to those of the redan, as may be seen in the plan.

As to the elevation, I would raise the top 3 feet from the ground, and sink the inside 16 inches, that is just as much as necessary to give the parapet a proper height; the summit must be flat, without bent or slope, that the fire may horizontally graze the country.

Two different motives make me here reject banquets; one is, that as we cannot give them less than four feet in breadth, including the slope, the communication would by this means be widened 8 feet, and consequently more exposed to the fire in the rear; the other, that the less the communication is covered, the more it will be plunged into from the branches of the intrenchment.

It is impossible to hinder two lines, parallel to each other, from battering one another at right angles; therefore one communication.

nication always fires on the next, and I know no other remedy for it, but to place lunettes at every other front only. These flanks would then cease to be hurtful to each other, and would protect the intermediate front by a reverse fire, which may be shortened some fathoms, if we would have it better defended.

VII. These kind of lines is already complicated enough, yet when we have more time than necessary for the essential dispositions, and the troops are not fatigued with service, it may be prudence in a general to seek means of prolonging their employment; besides the real use he would draw from this for the security of the camp, it is well known, that it is the most agreeable method of preventing desertion, sickness, and all the disorders, which idleness exposes a soldier to: so important a subject requires our most serious attention.

Tho' these schemes, speculative as they appear, should be difficult to put in practice; or they should have faults equal to those of the common method, or even more essential, it will be always necessary to mention them, to give them their full career, if I may be allowed the expression, and to shew what variety a subject, hitherto treated in so plain and uniform a manner, is susceptible of. I would therefore propose the enlargement of the work in view, tho' it were as considerable as it is otherwise.

The

The figure being traced as before, except-  
ing the redan, which is here left out, draw  
a line of defence from the flanked angle of  
one of these branches, to a point on the other,  
45 fathoms from that branch; from a point,  
twenty fathoms on its extremity, let fall a  
line perpendicular to the other line, which  
will be the flank; this point at 20 fathoms  
also serves for the direction of the faces of  
the lunette.

This alteration is but trifling in itself, since  
it is no more than a brake of 25 fathoms base,  
but it produces a very great one in respect to  
the fires: according to the first plan, those  
of the branches cross all on the retring angle,  
they cover it entirely with a parallel fire, and  
are crossed by that of the redan; but we are  
obliged to leave one space vacant, that would  
batter the lunette. According to the other, a  
different direction is given to a considerable  
part of the fire which is directed towards the  
flanked angle: for the fires of the new brake,  
the one part cutting the capital of the same  
branch, and the other grazing the opposite  
saliant, cross with the other defences.

We here employ all that space, which for  
fear of firing on the lunette, we were obliged  
to leave vacant in the first plan: this cir-  
cumstance, and that especially of the two  
additional columns of fire, which cover the  
salients, should recommend this plan, as well  
for using lunettes, as for forming a plain in-  
trenchment.



But this does not prevent us, even in the case we are speaking of, from making good use of the other. We should, as I observed, only place these advanced works in every other front, and the intermediate front will be very well traced after this plan. The large columns of fire which cover the re-entrant, serve as a lunette for the security of it; the salient angles will be well defended, since being common to the adjacent fronts, they will be crossed by four columns of fire.

It appears then by the broken *tenailles*, and by the double and treble flank, that this branch of military architecture, is as capable of producing as strong fortifications as that of places.

#### OBSERVATIONS on the seventh chapter.

The various methods of constructing re-trenchments, according to the different situations and circumstances, is the subject of this chapter. The author endeavours with candor to discover the advantages and disadvantages attending some sorts of works, not even sparing his own mistakes: the figures in plate 18, are instances of his impartiality; these were works he intended to make, being in a hurry, and not having sufficient time to consider their forms, and which, he says, had they been executed, would have fallen into all the defects of the common construction. It happens very seldom that an engineer has  
time

time to make a design of his project; without which, the author is of opinion, defects can hardly be avoided; not considering that something more is required, than what can be learned by practice. It is true that, in order to conceive a true idea of lines variously constructed, they should be traced on paper, and examined at leisure, either in winter quarters, or when nothing else is to be done in the field: but when an engineer is once upon a spot of ground to be fortified immediately, he should at first sight, without hesitation, know how to trace the different parts, so as to make the best defence that the circumstances will allow.

The author, with very little reflection, PL. XVIII. might easily have seen, without tracing the works on paper, that by making lunettes before the retring angles, close to the ditch, whose faces being perpendicular to the branches; these very lines, imperfect as they now appear, would then have had all the defence he could have desired, and have taken up the high ground between the line and the river.

After having shewn the little defence these lines are capable of, he gives some in plate 19, which are of a more perfect construction; their sides are indented, and form a saliant angle in the middle, with bastions at the angles of the polygon. It is certain, that the middle part of the front is strongly defended, but the bastions have no defence  
that

that I can find; and as the enemy will make their approaches in the capitals of the bastions, as being the weakest part, and not in the middle of the front, as the author supposes, all this great defence is of no consequence. It is something strange, that the author should neglect the most essential maxim in fortification, *viz.* to make all parts equally strong, and on which the true art of fortifying irregular places intirely depends. It is true, he seems to be sensible of this defect, and pretends to remedy it, by placing artillery upon the faces of the bastions, and felling trees, or making pits with stakes in them; but such trifling obstacles as these are soon removed, unless they are supported by a strong fire, which is not the case here; nor can the artillery be of any use, excepting it was placed upon the adjoining parts of the branches, where indeed it might flank the bastions, tho' very obliquely; but after all that can be done to remedy these defects, this construction is, in my opinion, not so advantageous as those mark'd fig. 2. and 3. in Plate 17. altho' the work is greater, and the construction more intricate.

In plate 20, are different constructions of retrenchments, of which the first and second are imitations of *M. Folard*, which our author thinks are not so well explained, as so able a writer might have done; and therefore he supposes the common construction as to the lines themselves; but in regard to



to the lunettes, they could not well be nearer the curtains than he has placed them, because they would not else answer the ends proposed, as projecting but very little before the other works: and if they are placed in this manner, the fire of the adjacent flanks will enfilade their gorges, and defend the faces but obliquely.

It is not so much the situation an author chuses to place a work in that is to be considered, as that which the figure or nature of the ground requires: and therefore these lunettes should, in my opinion, be placed so near the curtains, as to defend the faces nearly directly, and so constructed, as to be reciprocally defended by these faces: in this case the works would be as strong as their nature will admit of: as to the lunettes not projecting before the other works, it is rather an advantage than otherwise; since the defence of a work weakens in proportion as it projects beyond the rest; and it is always at the most saliant part where the enemy makes his approaches. This however supposes the ground to be every where even, or upon a level; but when a rising ground happens to be before a part of the line, that might be an advantage to the enemy, either by making his approaches there under cover, or if he should get possession of it, to raise a battery, or a fort to annoy the trenches: it is then of the utmost importance to raise a good detached work there, and to make a  
secure

secure communication from it to the line. The author makes a digression as to the abilities of officers, in respect to engineering; where he says, tho' an officer writes ever so well upon the different parts of the art of war, which he had an opportunity to know by experience; yet when he comes to treat upon fortification, what he says cannot always be depended upon; which is as much as to say, that engineers only are qualified to write upon fortification. But tho' an officer may perhaps not be so well acquainted with all the minute particulars; however, as it is his duty to understand how works are to be defended, and how to intrench himself upon particular occasions, if he is otherwise qualified, he may write upon that part as well as an engineer.

The third fig. in plate 20, represents the same work as the second figure in plate 17, with this difference only, of having a lunette before the redan; but for what reason he places this lunette so far from the redan is not easy to be guess'd: for if their faces were only about five or six fathoms from those of the redans, and perpendicular to the branches which form the saliant angle of the line, they would defend these branches, and reciprocally the branches would defend their faces, each other at right angles, which is the greatest advantage they possibly can have, according to the constant maxim of fortification. I suppose the author thought, that  
if

if the lunettes were placed so near, they might prevent the faces of the redans from defending the branches : this is certain they would ; but as the defence of the faces of these lunettes is at right angles, it is no more than to change an oblique fire for a direct one : besides the lunettes being so near, they could not be taken, as being strongly defended by the redan, and the enemy would be reduced to attack the salient angles of the line, which being defended by a direct fire, would make all the resistance that is possible. Besides all the difficulties of making the communications, which the author imagines to be none of the least, would be entirely avoided.

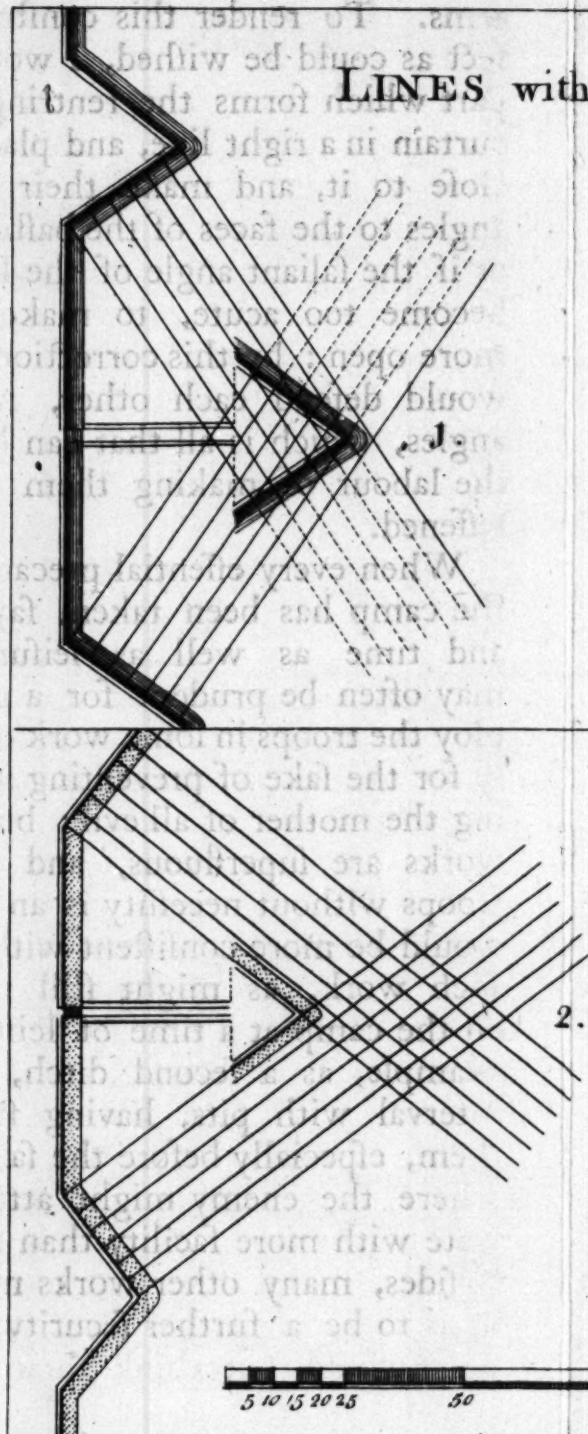
The author proposes to make an additional flank by the broken curtain, as may be seen in figure 4, plate 20 ; but tho' this produces an additional fire to the defence of the bastions ; it is however but very inconsiderable, since it reaches their capitals but at a great distance, and obliges the lunettes to be placed too far from the curtain, which, in my opinion, is a considerable defect ; for as their faces protect the capitals of the bastions but very little, and at a distance, the enemy, by attacking these capitals, after passing the faces of the lunettes, may take them by the gorge with all the troops in them, with very little trouble, notwithstanding the defence of the communication, which can be no more than one discharge of small arms.



arms. To render this construction as perfect as could be wished, I would make that part which forms the retring angle of the curtain in a right line, and place the lunettes close to it, and make their faces at right angles to the faces of the bastions produced; or if the saliant angle of the lunettes should become too acute, to make it something more open: by this correction all the works would defend each other, nearly at right angles, which is all that can be desired, and the labour of making them would also be lessened.

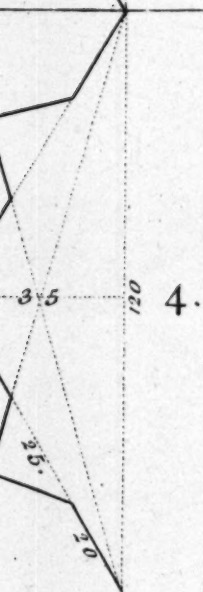
When every essential precaution to secure the camp has been taken, says our author, and time as well as leisure permits, it may often be prudent for a general to employ the troops in some work or other, merely for the sake of preventing idleness, as being the mother of all evil: but as all useless works are superfluous, and to fatigue the troops without necessity is an idle notion, it would be more consistent with reason to add such work, as might still more strengthen the camp at a time of leisure: such, for example, as a second ditch, and to fill the interval with pits, having stakes drove in them, especially before the saliant angles, or where the enemy might attack and penetrate with more facility than any where else. Besides, many other works might be made, so as to be a further security; and the soldiers would not think their labour lost, if they

# LINES with LUNETTE

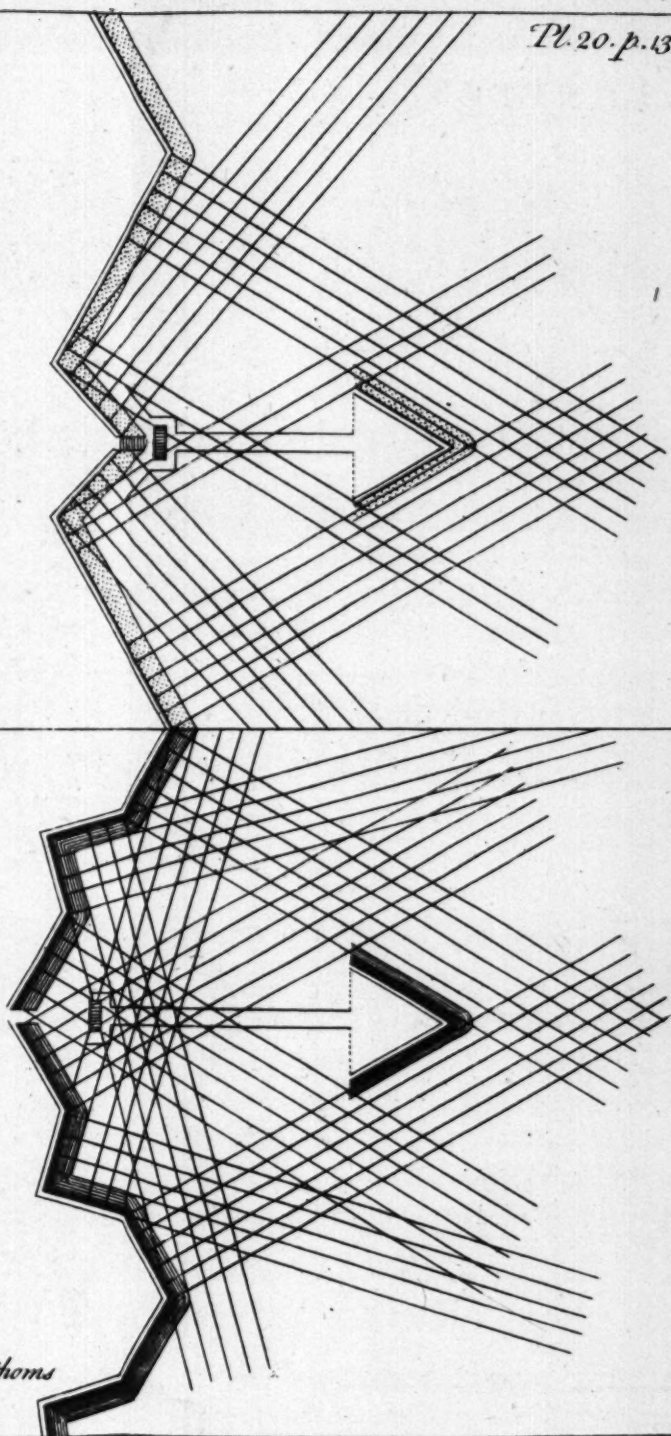


NETES

Pl. 20. p. 130



Fathoms  
150





It was concluded that it should be

# CHAPTER THE EIGHTH

It was concluded after the common method  
 I. It was and more perfect  
 II. Schemes of lines with detached  
 III. With detached works. V. Lines  
 VI. Works to be made  
 VII. Example of the  
 VIII. Fontenoy  
 IX. To be copied at their own

THE necessity of redans for the  
 defence of a line happens, as we have  
 seen, from the great obliquity of their faces;  
 pointing the curtain straight, we cannot  
 deny this to be thanks, and to add thanks  
 these pieces of land making bastions.  
 We gain by this an additional fire of the  
 guns, for that of the faces crossing in front  
 is instead of, and exceeds that of the re-  
 verses; it is true the extent of the figure pro-  
 duces this advantage in one respect, the re-  
 verses on the curtain, which is not we-  
 akened by it, as it is shortened in propo-

This made me resolve to bastion the in-  
 trenched camp at Vassan, and that of Joux.  
 I should have returned the same way.

they were convinced that it tended to their own preservation.

## CHAPTER THE EIGHTH.

- I. *Lines with bastions after the common method; their defects.* II. *A new and more perfect method.* III. *Schemes of lines with detached bastions.* IV. *With detached works.* V. *Lines detached in parts.* VI. *Works to be made for a day of battle.* VII. *Example of their use at the battle of Fontenoy.* VIII. *Lines joined to works closed at their gorge.*

I. **T**HE insufficiency of redans for the defence of a line happens, as we have shewn, from the great obliquity of their faces: supposing the curtains straight, we cannot remedy this but by flanks, and to add flanks to these pieces is actually making bastions.

We gain by this an additional fire of the flanks, for that of the faces crossing in front, serves instead of, and exceeds that of the redans; it is true, the extent of the figure produces this advantage in one respect, the rest depends on the curtain, which is not weakened by it, as it is shortened in proportion.

This made me resolve to bastion the intrenched camp at *Russenheim*, and that of *Spire*. I should have ventured this novelty with much more assurance, had I known myself  
sup-

supported by such an authority as the *Marquis de Santa Cruz*, but his book had not then appeared in *France*. "To flank an intrenchment," says he, speaking of that of an army, "I would not confine myself to salient angles, whose defences are obtained under very obtuse angles, by which the defenders are greatly troubled : but I would form bastions."

These kind of lines is without doubt better, and at the same time more beautiful than that with redans, supposing, however, that there are other real beauties than what are useful. We may then wonder that they were neglected, even to appear unknown, before the siege of *Philipsbourg* ; they were the first and only of that kind that I had seen.

Pl. XXI. I traced one part of them which had 130  
Fig. 1. fathoms front, 25 perpendicular, and 35 for the faces, the flanks were perpendicular to the lines of defence.

Being acquainted only with these, I shall give no others for examples ; and as my subject has obliged me rigorously to examine the common construction of redans, I cannot, dispense doing the same here.

These constructions have this in common, that the curtain is covered by so much fire, as to become in some manner inaccessible : this apparent advantage is no defect in itself, but it necessarily produces one. The fire a front can furnish, being always proportion-  
able



able to its extent, if we direct too much towards one part, another must want it : our greatest care therefore should be to distribute it equally throughout, having regard to where there may be the greatest occasion of it ; but that is not done here ; the curtain, the most rentring part, of course the strongest in itself, reaps almost all this defence ; and the parts most saliant, and consequently the weakest, that is the faces, have none at a distance from the angles, and are not flanked, but very near, and for a small breadth.

I don't know that hitherto these defects have been much regarded, perhaps they have been thought inevitable, as being nearly the same as those of common lines ; let this be as it will they do not appear less important than those we have already mentioned.

The first objection is, that the ditch being parallel throughout to the principal line, the counterscarp must hide one part, so that the enemy in the ditch cannot be discovered from the opposite flank. I have before mentioned this inconvenience.

The second, not quite so obvious, was made to me by *M. de Cormontaigne*, an engineer of great abilities and reputation ; it is, that the enemy, masters of a bastion, but yet too weak to march forward, will be dislodged, or driven back, with great difficulty ; for having their flanks covered by those of the work, they can only be attacked in front, and by a less front in proportion to

L

their's

their's and the number of their troops, than in a redan; because of the smallness of the redans and the great obliquity of their faces. I shall examine this observation with all the care and attention it deserves.

II. The greatest defects of these lines, being nearly of the same kind as those of the common method, we may remedy them by almost the same means.

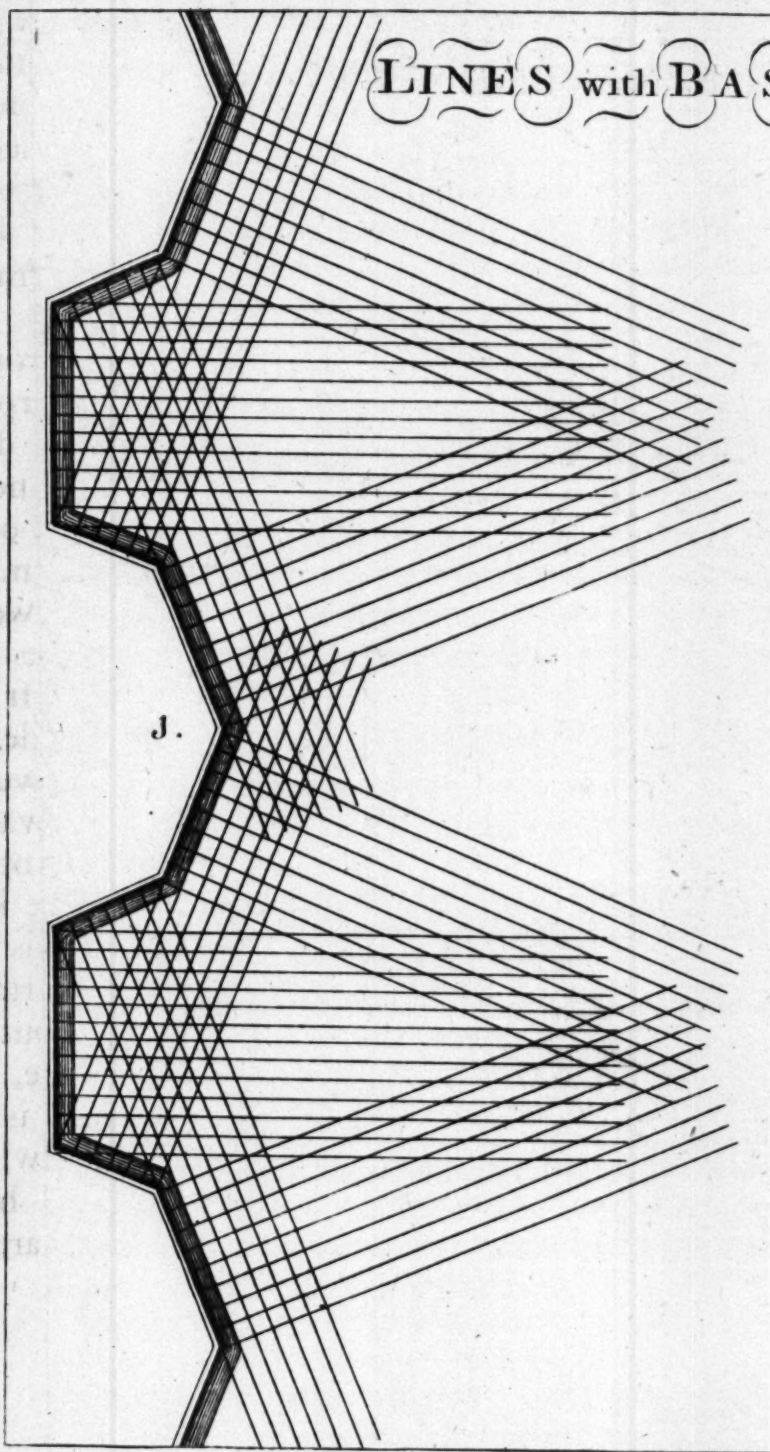
Pl. XXI. I always suppose the front 120 fathoms.  
Fig. 2. Give one fifth to the perpendicular; make the faces half the lines of defence; included by their intersection and the flanked angles; let fall the flanks square on this line, and thus form a broken curtain.

The figure shews that we thus gain two additional columns of fire on the capitals, and that there is more left for the curtain than it can want for its defence.

As to the cover which we find in part of the ditch of the faces, towards the angle of the shoulder, I know, no other remedy than what I recommend for the intrenched camp of *Spire*, and luckily that is sufficient. The hurtful part of the counterscarp must therefore be taken away to about three feet from the bottom: for example, if the ditch be seven feet deep, the side is sloped for four feet, in form of a *glacis*, which must be so directed as to be grazed by a line drawn from the summit of the parapet, to the point where the slope begins.

LINES with BAS

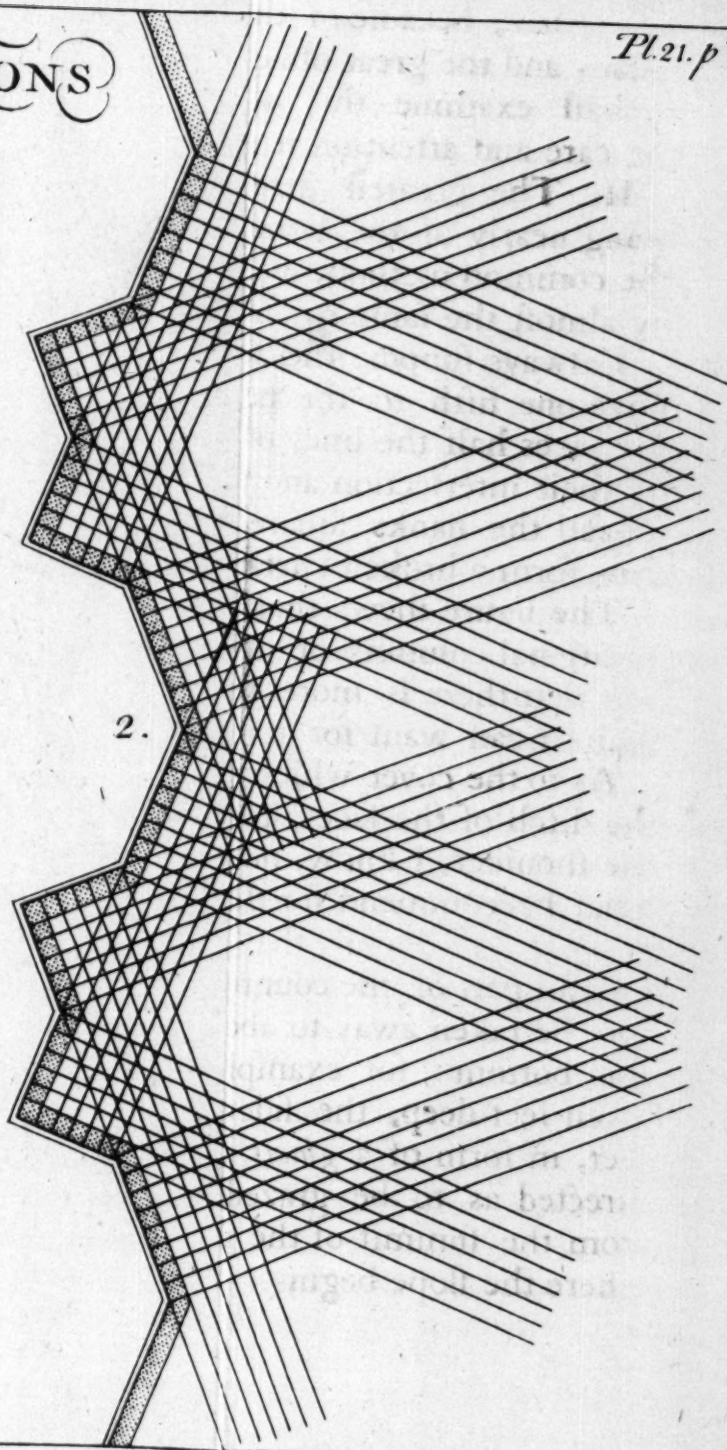
J.





# BASTIONS

Pl. 21. p. 144



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The first difficulties being got over, I pass to the last. The redan and the bastion supposed closed at the Gorge, reckoning from the principal line, the first contains 330 square fathoms, and the bastion 1770 $\frac{1}{2}$ : one of the gorges is 30 fathoms wide and the other 76 $\frac{1}{2}$ .

Therefore to attack the enemy with equal advantage we must occupy a front more than five times larger before the bastion than before the redan, in regard to the number of troops they can contain; but as we must only consider the extent of their front rank, this is reduced to little more than twice and a half.

I think we may compare these fronts in Pl. XXII; the following manner. Form a right angle Fig. 2. triangle without, on the gorge of the work; on each of the small sides, at their extremities joining the *hypothenuse*, elevate a perpendicular 60 fathoms long, from the middle of the gorge, and with this radius describe an arc of circle, and the fronts will be formed by chords.

I suppose all the fire contained in this part of the circumference, because the obliquity of the shot beyond these extremities would not sufficiently enter the work.

We shall then find in the redan five fronts, which may be advantageously placed in that space; one that is equal to the gorge, two equal to the small sides of the right angles

L 2

triangle,



triangle, and two others larger than these, and smaller than the first.

The bastion affords but three, one equal to the gorge, and two equal to the small sides of the triangle.

Without recourse to calculations, when superfluous, it is evident by the figure, that the fronts which can be disposed against the gorge of the bastion, are not near double in length to the sum of the others; for if we compare the arcs of the circle, we shall find that one is more than 133 fathoms, and the other only about 206. Lastly the radii of these arcs, that is, the distance from the point from whence I suppose the fire to come to the middle of the gorge, will be between 71 and 72 fathoms in the redan, and 91 in the bastion; another disadvantage in this last construction.

The observation must then be acknowledged just, and if we come to close with the enemy, it is easy to force them from the redan, being drawn up in form of a reversed coin; but after all, the gorge of the bastion is but 77 fathoms, and the total of the fronts, which batter it at right angles, is more than 184; therefore there is no equality between the assailants and defendants; and tho' I agree to this inconveniency, I doubt if the engineer who discovered it, thought it considerable enough to reject a method, otherwise so advantageous.

III. In 1743, necessity obliged me to invent a kind of lines which I think useful in certain cases; viz, when we are to turn a small river, or can fill the ditch with water. It was at the camp under *Landau*. *Marechal de Noailles* ordered me, when I was least prepared for it, to trace an intrenchment from the mill of *Ossembach* to below the village of *Offernheim*; it was near 2400 fathoms: this work was ordered to be begun by break of day, it was then almost night, and I half a league from the place. I did not know where to find piquets, nor any one to help me, and the workmen were to begin at the break of day: if, according to the saying of a great man, that the word *impossible* should be left out of the dictionary, it should be erased out of the *soldier's dictionary*; it is a mortifying word to make use of: the thing did not yet appear practicable to me. I therefore proposed to trace it in a right line, with some saliant angles at a distance from each other, intending to flank it by some detached works, when more at leisure.

An engineer has great reason to be satisfied with his orders, when the general who gives them is himself an engineer, and does not disdain to enter with him into the most minute detail. I pointed out the impossibility, which he was not ignorant of, and the expedient which had struck me; he understood me with half a word, and conceived, even before I had explained myself, the ad-

Pl. XXII;  
Fig. 2.

vantage of having a parapet and a river before one, when we have not a moment to lose in intrenching ourselves, and that the works with flanks that I proposed, furnished four columns of fire, instead of two, and being separated from the intrenchment by a ditch full of water, if the enemy took it they were not much more advanced, since they could not keep there; and in short that nothing was more advantageous, than to have artillery placed in such works as projected beyond the line.

The day was quite spent when I arrived at the place, and the fires I had lighted to shew the line were confounded with those of the camp, and to add to my misfortunes I had a fever: I was therefore soon obliged to give over; but at 9 next day the line was traced: in short, being worse than the day before, I had great occasion for so good an assistant as *M. de St. Paul*, and was also much obliged to *Le Chevalier de Beaufobre*, at present colonel of the *Hussars*.

This work begun the same day, was finished before I had traced the detached pieces because I was otherwise employed: and as it was thought that nothing more was to be done than what appeared, this long line without flanks was ridiculed with some appearance of reason; and the motion of prince *Charles* of *Lorraine*, having obliged us in the mean time to send a considerable detachment towards the higher *Rhine*, and to retire  
with



with the rest of our troops behind the *Moutre*, I doubt if this piece of work gained me any credit with most officers of the army.

We find the bastion here have not the inconveniency I have spoken of in the preceding article (for these lunettes with flanks are in effect detached bastions) since the enemy cannot keep there till he has done, that is, till he has forced the line: but this method is not good, when the ditch is not full of water.

IV. I practised another occasional method of fortifying, much more expeditious, at the same camp, from *Queichem* to the mill of *Offembach*.

This method has the advantage of the other, being practicable in dry or wet ground, it consists in covering the front of the line with detached works, turned so as reciprocally to defend each other, or those which may afterwards be added in their intervals.

When we are likely to be distressed for time or workmen, the distance from the middle of one of these works to that of the next may be 240 fathoms. If attacked in this state, the enemy cannot break thro' the intervals, without first taking these pieces, or being flanked.

If we have time, the intermediate pieces are constructed, and the line is then defended in the same manner as the fore-mentioned scheme for *Pilsting*, or what was practised in the plain of *Deckendorf*. We may

also observe, that in this case we are exempt from one of the great defects of lines in general, which is, that we cannot fall from them but by a small front: but as it is necessary, especially when inferior in number, to guard these great intervals, nothing prevents our closing the whole afterwards, by straight or broken curtains.

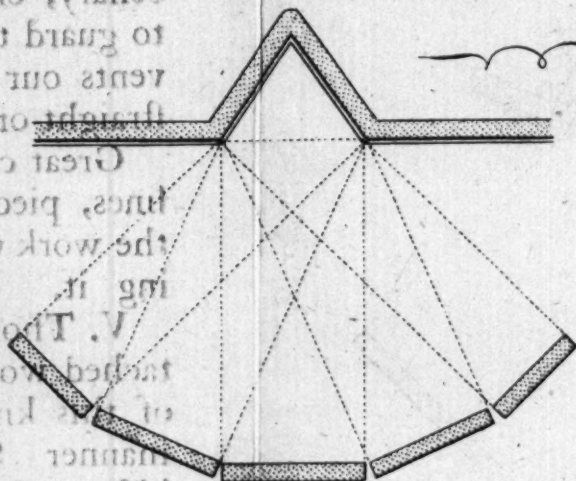
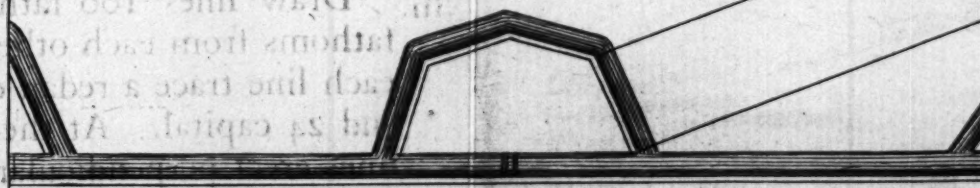
Great care must be taken in tracing these lines, piece by piece, lest we should batter the work which is to follow, instead of flanking it.

V. Those lines which are formed of detached works, tho' they may be esteem'd as of this kind, are traced in a very different manner. Such were those according to the history of *M. de Turenne*, which were rais'd by general *Merci* in 1645, for the battle of *Nordlingue*; each piece was compos'd of a redan, placed in the middle of two common demi-curtains, whose extremities were terminated by a hook.

As I only quote this from the plate, which had no scale, I do not know what were the proportions; but changing the figure a little, I would recommend the following construction.

PL. XXIII. Draw lines 100 fathoms long, and 100  
Fig. 2. fathoms from each other. At the middle of each line trace a redan of 30 fathoms gorge and 24 capital. At the extremities of these lines erect perpendiculars of 20 fathoms, for the brake of the branches; from the foot of the perpendicular to the summit of that of the  
next

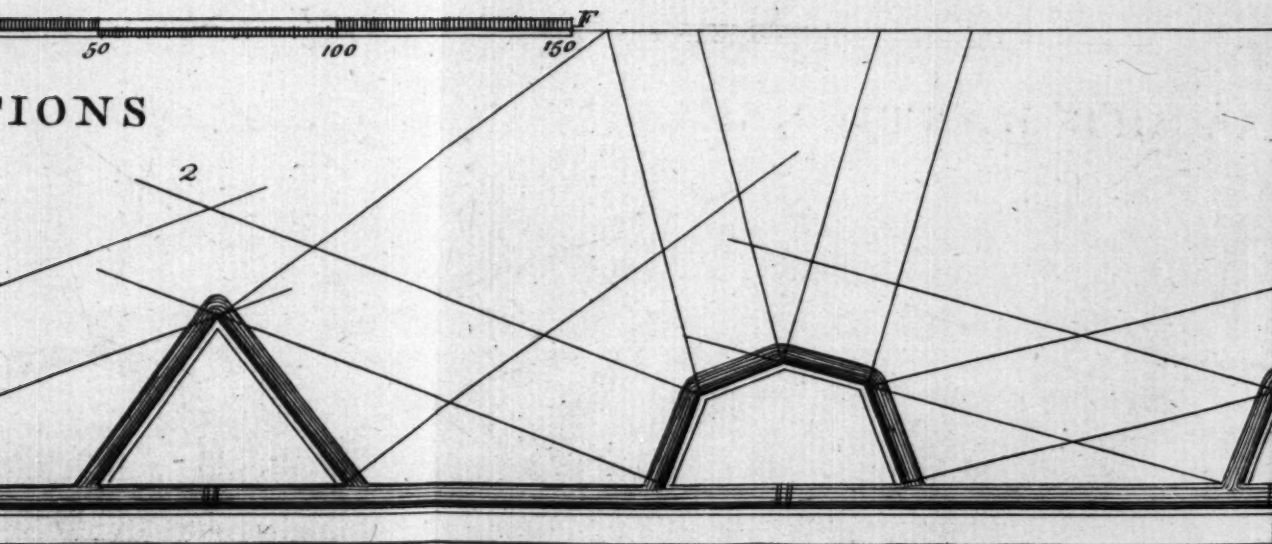
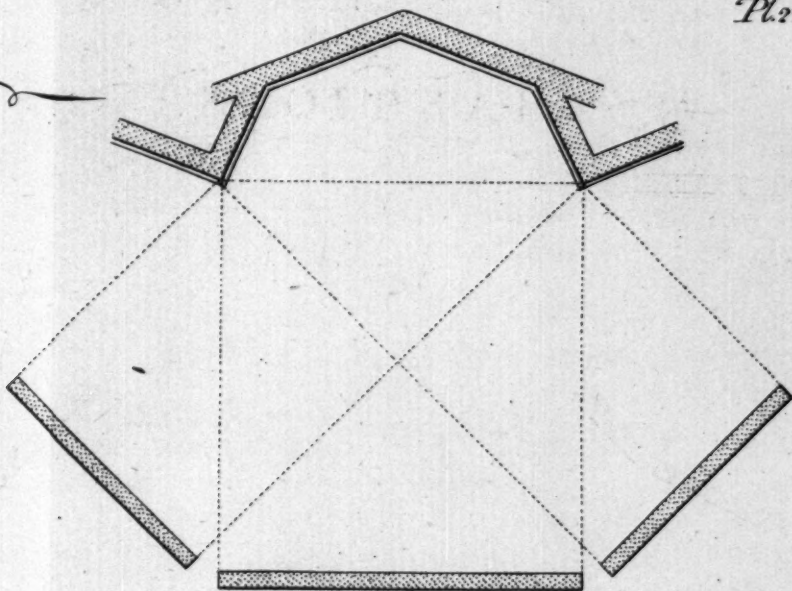
## LINES with DETATCH'D BASTION





ASTIONS.

Pl. 22. p. 147.



# ENGINEER

next front draw the line of defence, on which  
lay a battlement for the direction of the hook.  
These intervals are covered by 4 columns  
of cross'd fire, on which account I make  
them no larger: the greatest part of the  
branches have 3, without reckoning the di-  
rect fire, and the faces of the redans are  
flanked nearly at right angles by the whole  
length of the branches; advantages which  
the intrenchments of General Morda had not  
as the demi-circum formed a right line.  
As to cannon, they may be placed in the  
angles of the redans, or it we chuse only to  
use small arms in these works we may place  
them in the intervals, as General Morda did.  
In short, intrenchments, detached in parts,  
may be fortified after many different ways.  
All are good, in proportion as the intervals  
are, and each particular part, is more or less  
defended.  
VI. This subject naturally leads me, to  
speak of another kind of fortification, which  
does not differ much from this, tho' we can-  
not properly give it the name of lines. Ex-  
cepting the last, whose use is more doubtful,  
all the lines treated of, either suppose, that  
we seek to avoid an action, or are not wil-  
ling to lose the advantages gained by them;  
but their uses in regard to battles, are not  
confined to the defensive alone.  
When general, more than equal in forces,  
or resolved to risk an engagement, advances  
to a camp which he has reconnoitred, to  
stop

next front, draw the line of defence, on which lay 6 fathoms for the direction of the hook.

These intervals are covered by 4 columns of cross'd fire, on which account I make them no larger: the greatest part of the branches have 3, without reckoning the direct fire, and the faces of the redans are flanked nearly at right angles by the whole length of the branches; advantages which the intrenchments of general *Merci* had not, as the demi-curtain formed a right line.

As to cannon, they may be placed in the angles of the redans, or if we chuse only to use small arms in these works we may place them in the intervals, as general *Merci* did.

In short, intrenchments, detached in parts, may be fortified after many different ways. All are good, in porportion as the intervals are, and each particular part, is more or less defended.

VI. This subject naturally leads me, to speak of another kind of fortification, which does not differ much from this, tho' we cannot properly give it the name of lines. Excepting the last, whose use is more doubtful, all the lines treated of, either suppose, that we seek to avoid an action, or are not willing to lose the advantages gained by them; but their uses in regard to battles, are not confined to the defensive alone.

When a general, more than equal in forces, or resolved to risk an engagement, advances to a camp which he has reconnoitred, to  
stop



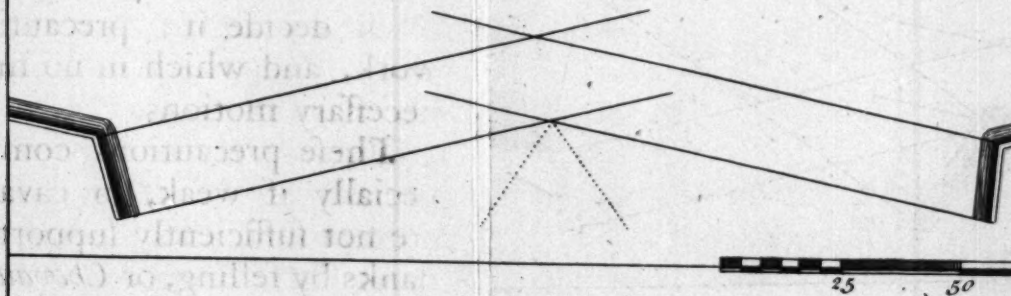
stop an enemy ; or by drawing nearer to them, will oblige them by his position to attack him ; will not attempt to intrench his camp at the moment almost of the action, and to begin works which probably he would not have time to finish ; he would not be-  
sides enclose himself, and put it equally out of his power to attack, pursue, and reap all the advantages of a victory ; but will seek to secure himself by those precautions which often decide it ; precautions easy, of little work, and which in no manner obstruct the necessary motions.

These precautions commonly consist, especially if weak, in cavalry, or the wings are not sufficiently supported, in securing the flanks by felling, or *Chevaux de Frise*, in deepening ditches with upright banks, in ruining bridges, in destroying fords, and in short, to render them every where as inaccessible as possible.

When there are villages, or some great building towards their extremities, they must be put into a state of defence without loss of time ; the same use is made of them which are but at a small distance before the line, esteeming them as fixed points and flanks. In short, if we have leisure large redoubts are constructed, if not on all the front, and so as their fires may cross, at least in the weakest places, or from whence the artillery can be most advantageously served.

It is useless to add more, for as all depends on circumstances, nothing positive can be said ;

## LINES of DETATCH'D WORKS.

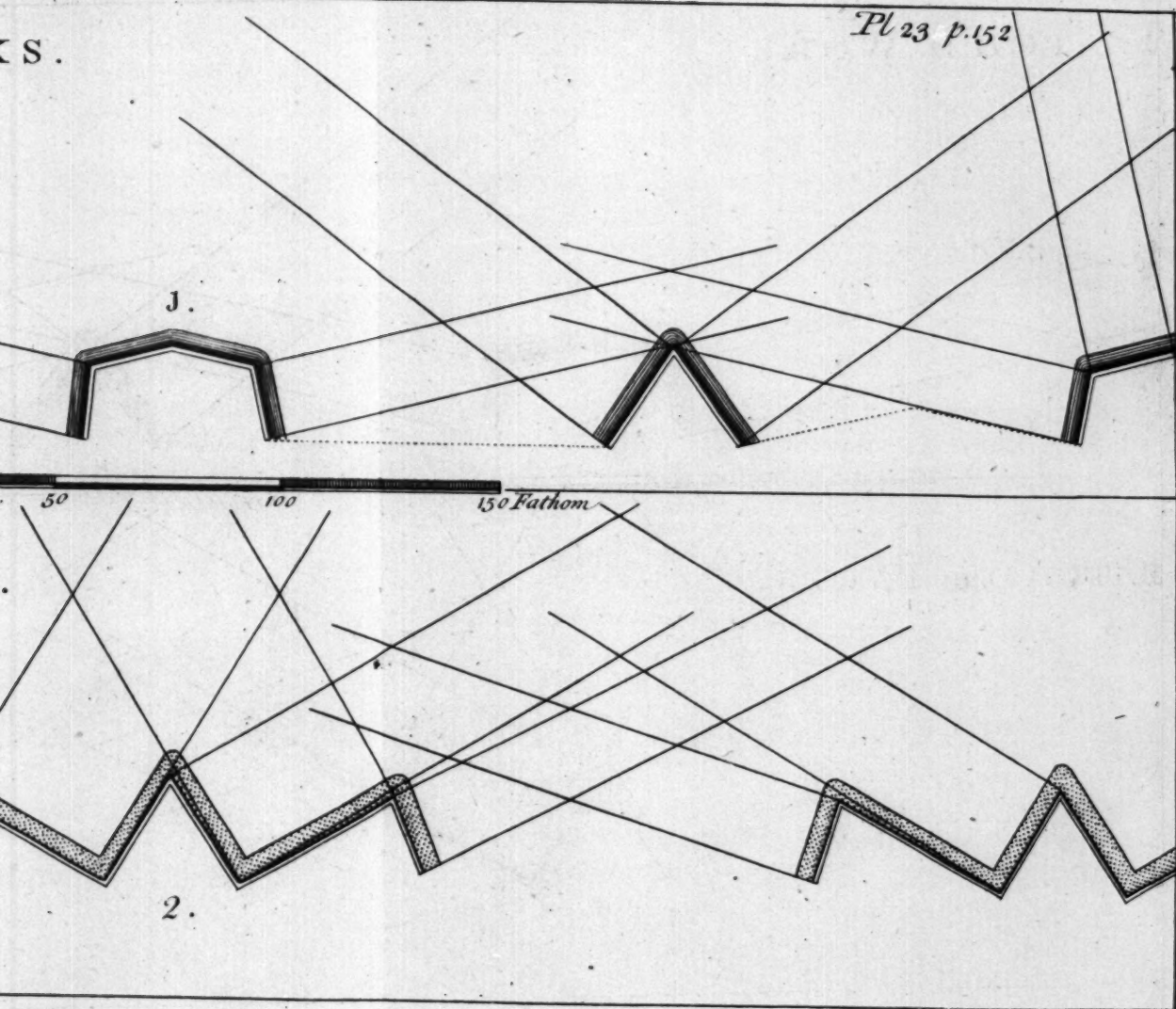


## LINES DETATCH'D in PARTS.



K S.

Pl 23 p. 152





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said; and speaking in general would only be unnecessarily repeating what I have said in 7th article of 4th chapter.

VII. I cannot give an example of these precautions, more known, or more convincing, than that of the battle of *Fontenoy*: but as it is foreign to my subject to give a detail of the engagement, I shall confine myself to PL. XXIV. what concerns it, by the wise dispositions of a general, who all *Europe* confesses, justified in the beginning of that war, what a celebrated writer had predicted of him (a).

The right of our army being supported by *Antoin*, and consequently by the inundation of the *Scheld*, it was necessary for greater security to intrench the village, which was done in the night, by the troops that guarded it.

From *Antoin* to *Fontenoy*, another village intrenched with great care, and which was the centre, is 800 fathoms. This front was covered by three redouts, the first on the side of *Fontenoy*, the second 100 fathoms from the first, and the third 140 fathoms from the second, they were constructed, or rather roughly thrown up, the same night. The want of time, in all appearance hindering their increase, the fortification of the centre was principally attended to, which was the

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(a) M. Folard, speaking of the method of firing which M. Saxe had introduced into his regiment, "a method (says he) that I admire, as much as its inventor, whose genius is one of the greatest military one's I know; and we shall find in the first war that we are engaged, that I am not mistaken in what I think". Book II. Chapter 14th.

most essential, because the rest was flanked by the village of *Antoin*, which commanded almost all the breadth.

The left, squaring with the front, extended to the woods of *Barri*, joining to the village of *Ramecroix*; we had felled the wood at that place, and posted the regiment of *Grassin* in it, to observe what passed there.

It is plain we did not find this wing so easy to support as the right; but the wood, crowded as it was with infantry, the felling which covered the edge and two redouts, which were raised there, supplied this so well, that the brigades which formed it, served in the heat of the action as a reserve to the centre.

I need no other proof of the necessity of these works, than the obstinate bravery, with which the *English* attempted to force *Fontenoy*, despairing to break through elsewhere. This post, by the best accounts I have seen of the action, was a capital point, and of greater consequence to us to defend it, least the enemy, once masters of it, would have maintained themselves in it, and have cut our army in two.

I have nothing more to add on this battle, but the steadiness of our troops; for works so imperfect, could not be supported against so vigorous an attack, without great resolution. Yet all the fire of the village and the redouts, could not prevent the enemy from penetrating between both; a bold courageous attempt,



attempt, and which seemed once to have given them the victory, but which at length, by a prudent motion on our side, was turned in favour of us.

VIII. The importance of these articles, and their connection with the preceding, will favour the digression in the last: but to return to our subject.

It has for some time past been strongly debated, whether or not it be proper to join works closed at their gorge to lines: it was formerly practised, at least we may judge so by those of circumvallation and countervallation. Most treatises of fortification prove this, and not only redouts, but stars, squares, with half bastions, and other considerable works.

The *Imperialists* seem yet to use them, for we found them in 1734 at the lines of *Estlingue*; as for us, we have abandoned them; the last time we used them was I believe at the lines of the *Loutre* in 1706, where we erected some redouts in the most exposed places, and chiefly to defend the dams, and to place batteries in.

At the same time perhaps we abandoned the epaulments for the cavalry, whose use we shall treat of hereafter; it is not only necessary to know what is practised, but what should be practised; that is, whether we have greater reason to suppress the one, or neglect the other; for it is sometimes with these, as with fashions, which many follow without reflection.

reflection, and some for fear of being thought singular.

*M. Vauban*, in his memoirs on the conduct of sieges, says, these works were no more constructed, because they were found dangerous; but the only reason he alledges in his *Treatise of the attack of places*, wrote many years after, is that of the brevity of sieges; thus he does not determine definitively, besides he only speaks of the circumvallation.

I shall not take upon me to decide this point; therefore what I shall say, must only be regarded as one single opinion, which I am obliged to venture by the nature of my subject.

XXXII.  
Fig. 1.

There is no doubt, but this method, well managed, might be useful in many respects. These pieces elevated more than the rest, placed to advantage, by their protection and command of ground, might defend the adjacent parts; they are asylums at small distances, under whose fire the troops, drove back, or broke, may take breath and rally; it is also common in a brisk attack well supported, to be forced to abandon a battery, which when regained, and it is not without example, the enemy will have nailed up the cannon or have been very careless; by this we are less exposed to such inconveniencies.

According to the *Marquis Santa Cruz* (a) we gain another advantage. He would have us regard an intrenchment, as divided into four parts, and each part given to the com-

(a) On encampments, chap. 7. sect. 2.

mand of a general, who should march with his troops, to form in the place designed, if the enemy attacks on that side; and they cannot form with more order and tranquillity than under one of these pieces.

Thus we have shewn their advantages; on the contrary, if the enemy once enter these works, the loss of the lines is almost certain, by the difficulty of dislodging them.

If this is the only inconvenience, as I believe it is, we may easily remedy it. These works are of evident use, they must then be made; we have every thing to fear if the enemy once take them, they must then be constructed with so much care, as to hinder their access, and not expose ourselves to such danger.

When I say they must be made, we must understand, that it is not in indistinctly on every occasion, but only when we have time to put them into such a state, as not to be carried by assault, and principally in lines constructed at leisure, and designed to last a long time.

All kinds of works are not proper in this case; we must above all avoid those which batter any part of the intrenchment; for in an alarm in the night, and often in the day, the soldiers bordering the parapet, fire confusedly on all sides. The star, a dangerous piece, if within reach of another, ought for example to be avoided. The chief care, in my



my opinion, is to perfect the works, and cover the space between as much as possible.

#### OBSERVATIONS on the eighth Chapter.

The manner of constructing lines and re-trenchments is here continued ; but, as in the former chapter, those made with redans, or with saliant and retring angles, have been chiefly considered ; here they are made with bastions, as may be seen in plate 21. The first figure represents one constructed in the usual manner ; but as the ditch is but narrow, and its counterscarp parallel to the parapet, a part near the shoulders of the bastions cannot be seen from the opposite flanks ; for which reason it should be sloped ; and if a greater defence be desired at the saliant angle, the ditch may be widened from thence towards the shoulder. But because the construction of bastions requires too much time and labour, it is not always convenient, nor necessary, to make them all round ; besides, all parts are not alike exposed, and therefore the weakest ought to be strengthened by such works, as to render their approaches as dangerous as that of the rest. This was done at the siege of *Philipsbourg* in 1734, where the line of circumvallation was partly constructed with bastions, and partly with redans : the part most exposed had besides a horn-work added before the curtain ; and others had double ditches, with

with pits full of stakes between them; lastly, the part near the woods was strengthened with felling of trees.

As the situation of no camp whatsoever is on all sides the same, but has either a river, morass, or a rising ground before it; it is the engineer's duty to make use of all the advantages which nature affords, and to supply its defects with such works as are most convenient for the purpose.

The author observes, that as the strait curtains have no other defence than directly before them, and the greater defence of the front is directed towards the part least liable to be attacked, he gives an example in the second figure, with broken curtains; as hereby a second flank is added to the defence of the bastions, and the fire is in effect more spread and better divided. It may however be observed, that when ravelins are placed before the curtains, this second defence becomes in my opinion useless, and in that case I prefer the strait curtain before the broken one.

The author starts an objection against lines with bastions, in my opinion more curious than useful, so far as relates to the real defence: but as all faults, tho' only in appearance, should be examined, to prevent the reader from falling into mistakes, we shall endeavour to remove all suspicions which the author here insinuates. He says, when an enemy has once got possession of the bastion,

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and

and is not strong enough to advance farther, it will be attended with greater difficulty to drive him out again than out of a redan; this he endeavours to prove by the two first figures in plate 22; where he observes, that a greater number of troops may be placed before the redan, in proportion to the enemy it can contain than before the bastion, but the author forgot that the bastions are well defended by a grazing fire, and that single redans have no defence at all; besides, as the bastions are more spacious, there is more room for placing troops in them to defend the enemy's approach, and consequently the attack of a bastion is infinitely more dangerous than that of a redan. But let us even suppose, that the enemy has got possession of the one or the other, will there not be a sufficient number of men to drive them out again? they cannot be succoured in the bastion without suffering a furious discharge of artillery and small arms from the opposite flanks; unless the defenders give all over for lost, and run away, they will have it always in their power to drive them out of the bastion, and that with more slaughter than out of the redan.

The second figure plate 22, represents an intrenchment, intended to have been made close to a river; and as it was to be executed directly, time would not permit to make it of any other figure than a right line; but detached bastions and lunettes were to be added



added afterwards, such as are marked here, whereby the author imagined it would have a good defence; because, if the enemy should get possession of any of these detached works, he would be stopped by the wet ditch, and soon be drove out again by the gauling fire from the opposite part of the line. But as the faces of the detached bastions are not defended from any other part, this construction is defective on that account; whereas, if the outworks were constructed in such a manner as to defend each other, they would then be able to make all the defence that could be expected. How it is that the author did not perceive this defect, which is so contrary to his established principles, is impossible to know; unless age and infirmity had deprived him of his former sagacity, which is not unlikely, since he died soon after this work was published.

When the approach of an enemy is so sudden, as to leave no time for quite finishing the retrenchment, detached bastions and lunettes should be made at proper distances, so as to flank each other, and the curtains must be supplied by fellings of trees, if they are at hand, or by all kind of wheel-carriages, or else by stakes, timber, &c. and if there is any time afterwards, the curtains may then be made. But if a general is willing to run the risk of a battle, artillery and musketry must be placed in these detached works, and the intervals left open for him to march out

in order of battle when he thinks proper: if the enemy is resolved to push thro' these openings, the fire from the artillery and small arms, coming out of these works, may perhaps make him repent of his rash attempt, or at least disorder him in such a manner, that if the troops march in good order against him, it will be no difficult matter to defeat him.

The first figure in plate 23, represents an example of this kind, with this difference only, that the advanced works do not flank each other but very imperfectly, which is so much the more surprizing, as the author insists so much upon it, in most of the former parts of this work: whether he imagines these flat bastions to be more commodious, or that the enemy will rather chuse to pass between than attac them, I do not know; but in my opinion he will not pass by them, before he has destroyed their faces, and has taken them, which he may easily do since there is nothing that can prevent him, if he has artillery, and without which no army now marches; on the contrary, it is what the success of all actions chiefly depends upon.

The second fig. plate 23, represents another kind of detached works, which requires more labour and more time then the former: it is true, the parts defend each other much better; but I think the end of the one does not so well defend the end of the other, than  
if

if their defence was just to graze the opposite angle: be this as it will, such examples as these are always useful, as they enlarge the number of different manners in which lines may be made, and sometimes one form, at others another, may be used, according as the nature of the ground will permit, and all of them may be useful in different occasions and circumstances.

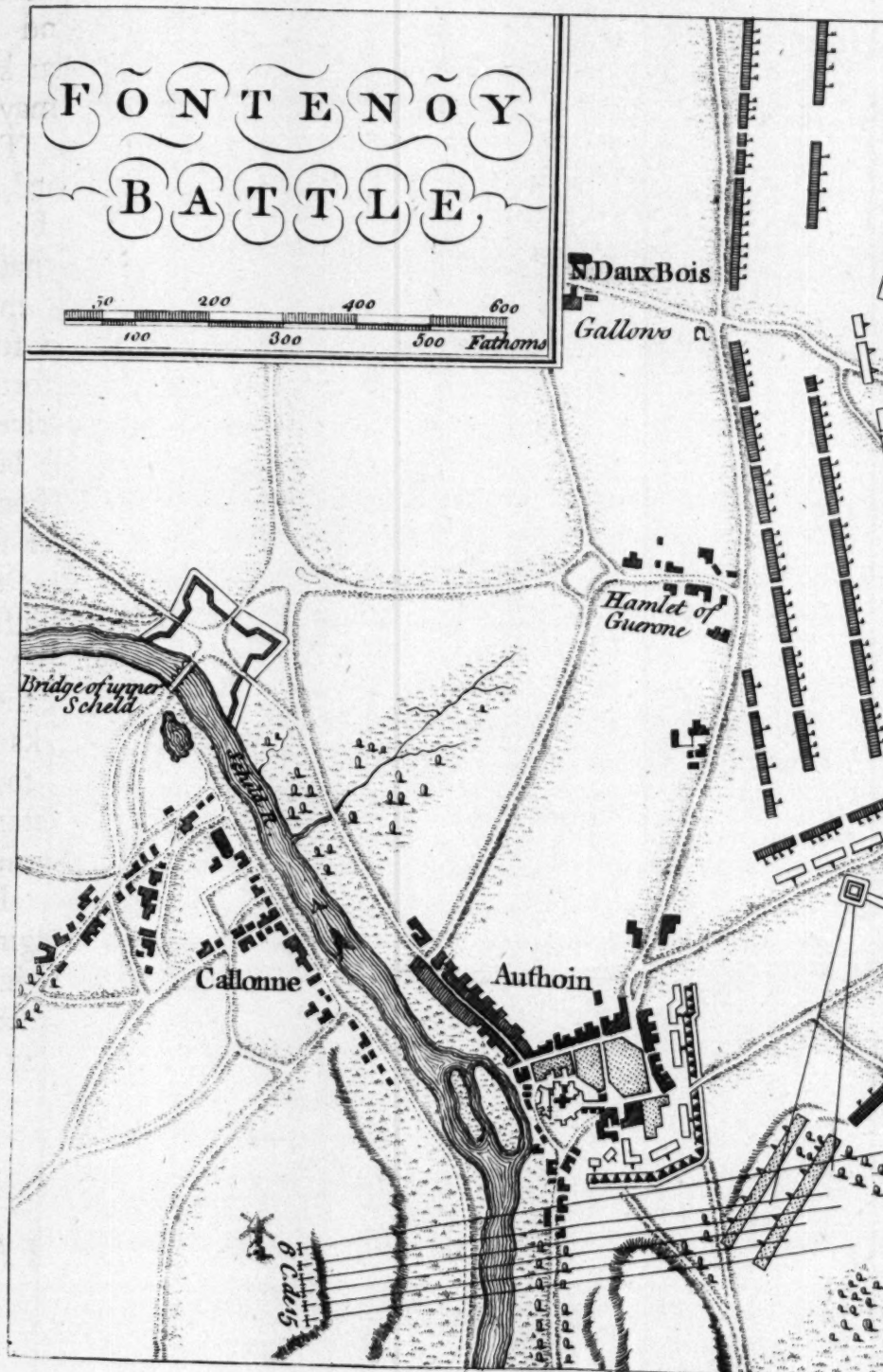
After all the different constructions of lines that the author could think of, he says, it has been a question for some time, whether it was proper or not to join works inclosed on every side, to lines or retrenchments; that is, redouts or forts. Some authors are of opinion, by placing them at proper distances, that when an enemy has entered the lines in some parts, the troops in the adjoining parts of the line may rally and form themselves under the protection of their fire; and that they serve as so many points fixed, where the troops are to join, in case the enemy should penetrate the line in any place. On the contrary others maintain, that such works are dangerous, in regard, that if the enemy should get possession of any, it would be very difficult or almost impossible to drive him out again. In all questions of this kind, the general manner in which they are proposed renders them seemingly more difficult to solve, than they otherwise should be; for if a particular work is not proper upon one occasion, is there any reason for its not being



so in any other? It would be much more to the advantage of the reader, to find out where and when a work of a particular kind may be useful: for there is none but may be good on some particular occasions. Thus when an advanced fort can be turned, or one near the sea or a river can be attacked in the rear, it is evident that it should be fortified all round; how many batteries have been taken, as well as forts, for want of this precaution. As to forts in or without lines, if it is difficult to drive an enemy out of them, it must likewise be as difficult for an enemy to get possession of them. The query lies then, whether such a work may not be made so strong, as that the taking of it would cost a greater loss of men, than the possession is worth; that this can be done there is no doubt of; and therefore when a general judges such works necessary, he ought to see it made, so as to answer his design; but if time or circumstances will not allow it, he would be to blame to expose his troops in a useless manner. It is upon such occasions, that the judgment of a general, and the skill of an engineer, must decide what is to be done, in order to secure his army from the danger of being defeated.

# FONTENÔY BATTLE

50 200 400 600  
100 300 500 Fathoms

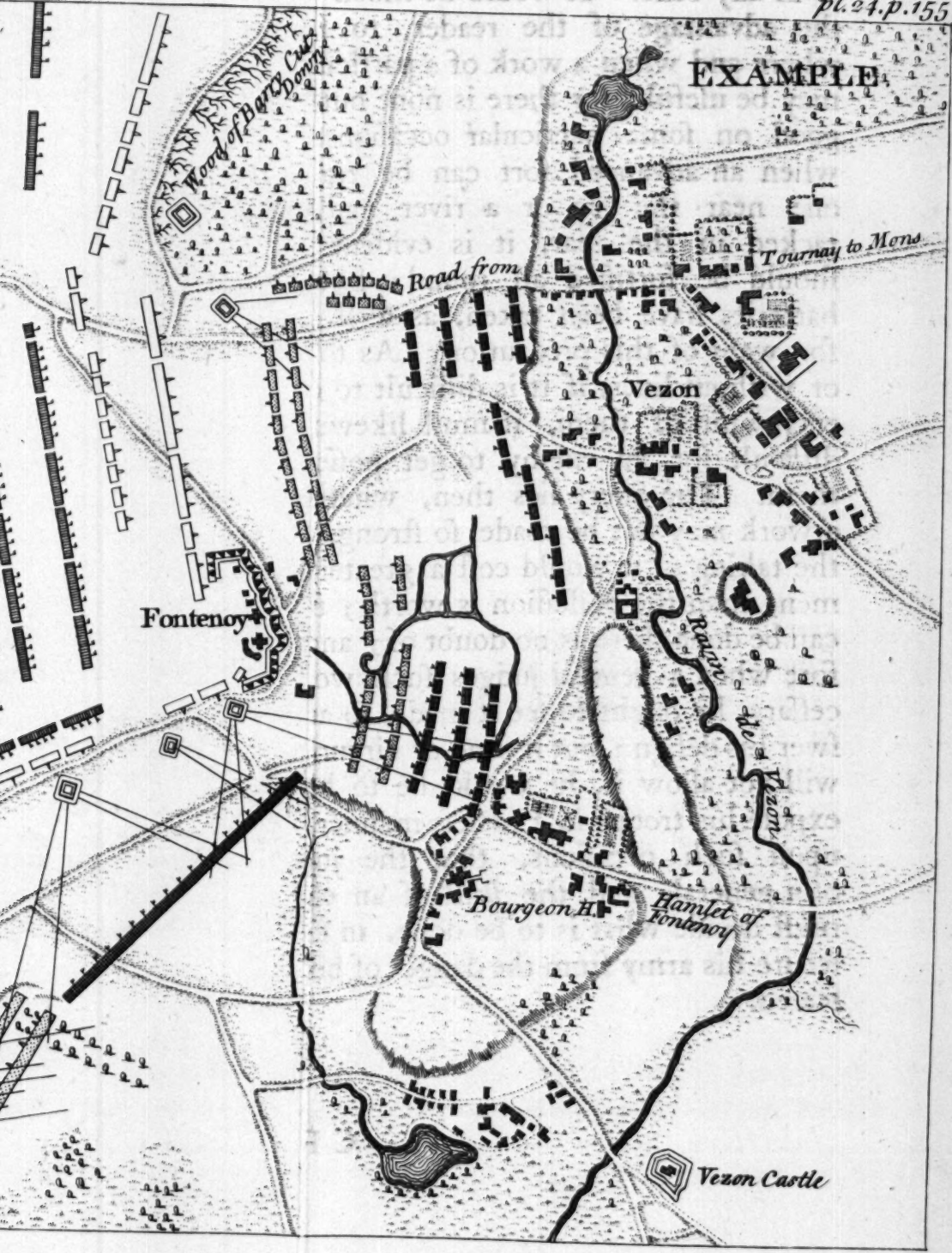


FIELD

in any other, it would be much

pl. 24. p. 155.

EXAMPLE







## CHAPTER THE NINTH.

- I. *Advantages to be drawn from a river, to cover lines.* II. *What is to be done in flat ground, when under the fire of the intrenchment.* III. *When it is at a distance from the whole, or any one part.* IV. *Of inundations; case where they may be made by single dams.* V. *Those made with sluices; their inconveniencies.* VI. *A more perfect scheme.* VII. *Scheme of an inundation for lines that are to stand a long time.* VIII. *Multiplicity of dams; means of correcting them.* IX. *Dams too long: means of defending them.* X. *Recapitulation of all these defects.* XI. *A new method of forming inundations in flat ground, in any place.*

I. **O**F all the assistance that can be expected from the natural situation of the ground for the defence of intrenchments of great extent, such as lines, there is not any more advantageous than a body of water, which is, or can be made, so deep as not to be forded.

This assistance, so desirable, would naturally present itself, without any necessity of improving it, whenever there is a large river in front, was it not for one circumstance, always to be joined to it, namely, that it might not be turned by the enemy.

It is very rare to find these advantages united: the course of a river, such as we here suppose, is always of so great extent, that it is impossible to line one of its sides entirely; and whatever may be the situation, or extent, the intrenchment will not hinder an enemy from passing above, or below it.

These rivers therefore, speaking in general, cannot serve for this use, but may become themselves almost an impenetrable barrier, by the help of much less, and quite different works, which we shall treat of in chap. 10.

Most small rivers are preferable in this case to large ones, for they commonly rise in the mountains, and running through a flat ground for some leagues, empty themselves into others much more considerable.

The great river and the mountain, in this case, serve to close and support the extremities of the line, and there is no more to do, than to render the front difficult of access, by the assistance of the small one; which is executed after different manners, according to time, places and other circumstances.

II. We have before observed, that when a rising ground or eminence runs parallel to the river, the line must be traced on it, as well to have a command, as that the camp may be more dry and wholesome, and the communications be on firmer ground, the better for carriages.

When



When the line thus traced is every where at a proper distance from the river, that is from 80 to 100 fathoms, it is a great advantage, because the passage is defended by small arms, without much labour and trouble.

If the meadows between are level and of a great breadth, so that they cannot retain the waters, or if time or means is wanted to undertake a greater work, it will be sufficient to raise them within their own banks, and keep up the water at certain spaces that it may not be forded; there are few that have not banks 5 or 6 feet deep, and that is sufficient; if they are steep, they are a greater obstacle to the enemy.

These waters are commonly supported by dams of earth, which being raised above the banks, force the water over the meadows; these works, the only ones I have seen, have a great inconvenience, as they serve for bridges to the enemy. Those I invented at *Deckendorf*, and used in 1743 at the camp of *Queich*, are exempt from this defect.

Their number depends on the greater or less fall of the river, and the height of its banks from the water; for example:

If this fall be two feet in 100 fathoms, and the depth of the bank only five feet; the dams must of course be repeated at every 25 fathoms, in order to make the water rise four feet and a half, which is the proper height to prevent its being forded.

But

But if this fall be only six inches, and the banks 7 feet, a dam at 500 fathoms distance will produce the same effect.

III. In the preceding article, I have supposed the whole course of the river under the fire of the line; a very advantageous circumstance, because the enemy may be prevented from throwing bridges over it, or cutting the dams; yet when the river runs above 100 fathoms from it, which I reckon a very proper distance for small arms; by additional works, as much or more assistance may be drawn from it.

Pl. XXV. If it runs off in elbows, which are neither  
Fig. 1. too open, nor too much sunk, some advanced works, joined to the intrenchment by good communications, will be sufficient to protect them.

Pl. XXV. If the depth or breadth of these curves  
Fig. 2. render that expedient subject to difficulties, a canal must be cut from one extremity of the curve to the other, in a strait line, observing to dam the old bed, as will be shewn hereafter, lest the enemy should turn off the water.

When the river is every where at too great a distance, a new bed must be dug for it, in order to draw other advantages besides those which the nature of the situation affords.

The direction of this new bed requires some essential observations: if the eminence, on which the intrenchment is supposed to be, is too high to carry the water up, or the side

next

next the meadow very steep, the canal may be cut from 15 to 20 fathoms distant, or more, if that is not sufficient to command it throughout, throwing the earth on both sides, in form of a glacis, which increases the depth. I say from 15 to 20 fathoms, because that distance does not diminish the effect of small arms, and a soldier, especially if he is not well disciplined, will be less confused, and fire more exact, than if the enemy was nearer.

Where the hill is steep, the line should lie as close to the edge as possible, and the side scarped, to render it difficult to mount the intrenchment; and where it is necessary to run off from the side, it must be made in form of a glacis, so as to leave no cover before it, which also furnishes earth for its construction; at least in the first case, without being under a necessity of digging a ditch, which being very low in regard to the summit of the parapet, will be badly defended.

In the other case, that is, if the intrenchment slopes gently down to the meadows, and the river can be brought there, nothing better can be done than to turn it into the ditch; which is then indispensable, as well to defend the access to the parapet, as to get the earth of which it must be made.

The river, which must be dam'd at the place it quits, and where it falls again into its old course, being at least sufficient for a reservoir to supply these two different canals with



with water, will also serve as a double barrier to the intrenchment.

IV. When the river flows without much rapidity, in a valley, border'd by risings, or when the ground rises gradually to the right and left of the river, all before it may be laid under water.

These inundations are made by dams of earth, which barring the river and the lowest part of the ground, retain and elevate the water; but as the water may carry away the dam if it shou'd overflow, care must be taken to make proper voiders.

Experience shews, that shallow water flowing on natural ground, does not hollow it, when it can extend itself. In consequence of this observation, whenever the valley slopes towards the river, there is no occasion for any other discharger than the ground itself beyond the dam; but for greater security the ends must be hurdled and gazon'd.

Another material advantage results from this work: for, whether the enemy cut the dam, or turns off the water by a canal, they can only drain one part of it; because to drain it entirely, they must dig and advance, as it runs off to the very lowest part; which as not to be done in one night, affords time to discover and oppose them; besides, they cannot do it without being greatly expos'd to the fire of the intrenchment.

V. These natural dischargers save much work,

work, and do not require great care in using them; but they are only to be us'd in such places as I have mention'd. But where the valley is level, or so narrow that the ends of the dams must be carried to the rising grounds, or even from one hill to another, it is evident, recourse must be had to other means. In that case sluices of wood are constructed, and placed according to the use they are design'd for.

When they serve as dischargers only, they are erected on the meadow, and the flooring fix'd on the level of the ground. The advantage resulting from this, is that there is no excavation requir'd but for the foundation, and these sluices being less high by the depth of the river, require less time and wood for their construction; they are also easier manag'd. These advantages are counter-balanced by different inconveniences; the river not being able to pass over the flooring, cannot have its natural course, without cutting the dams that stops it; which is necessary to be done, when the enemy is at a distance, or when at the end of the war, in order to drain the inundation.

These dischargers require besides a continual attention; for the basons once full, the vanns must be rais'd to a certain height to let a quantity of water pass, exactly equal to what enters; I say exactly equal, for if they are rais'd too high, the inundation falls, and if

if the opposite extreme, it may perhaps blow the sluice and carry off the dam.

A few hours rain, or a sudden thaw of snow, considerably swells these mountain rivers; they must therefore be watch'd night and day. In short, a cannon shot, or some defect in the wood, or their construction, may disorder the whole in a moment.

VI. The count d'Amale having order'd me during the campaign in 1743, to put the lines of the *Loutre* in condition; these considerations oblig'd me to seek some method more simple, more sure, and less fatiguing to disengage from the superfluous water some new dams I wanted to raise, and repair also most part of the old ones; for my design was to dam those sluices most expos'd to cannon; and those that are made as low as the bottom of the river, support a great height of water; which renders them less secure and more difficult to manage.

I was resolv'd therefore to use reservoirs of wood, the flooring laid on the interior side, three or four feet lower than the summit of the dam, had according to this scheme a convenient slope. Five posts with grooves divided the entrance into four equal parts or passages, making together 24 feet opening, which is double the common breadth of these sluices, and may perhaps appear excessive, if I did not give my reasons for so doing.

Water



Water passing thro' a space double in breath to another, runs about half as high, which renders the inequality of the body less sensible; it is therefore much easier to keep the inundation at a certain height by means of these shutters.

Besides, if one of the upper sluices is carried off, or one of the dams should burst, all is in danger, if the dischargers are not large enough to give sufficient room for this additional water to rush out. It is for that reason I make the floors of the reservoirs so low; for in such an emergency all the shutters must be rais'd, tho' it does not appear necessary; for the upper waters continually increasing the breach they have made, come down suddenly in greater abundance.

These reservoirs should be made at a little distance from the line on the meadow, and not in the river, because the depth would render them less solid. As they have less wood work uncovered, and as the shutters supply the place of vanns, they are more secure from cannon than sluices, to which I think them preferable, as well for the above reason, as being of a much lighter and simpler construction, there is no more Time required for them, than what the soldiers, or pioneers employ to raise the dam, so that all is finished at once.

VII. When these lines are made to subsist all the war, or even in peace, one would chuse that these inundations may be made  
and

and filled on the first order, that is to say, in the short time necessary for filling or emptying their basons, some little additional work must be done.

Each dam must in this case have a sluice, the cill of which must be as low as the bottom of the river, and the floor large enough to let the water pass at all times, the course of the water not being constrained, the dams need never be cut to let out the water on any emergency, when they are settled and well sodded; such in short as we need not fear. This is the only use I think we should make of these sluices, as well for the reasons already given, as the following.

*First,* Their height being equal to the depth of the river, it is often very difficult, and sometimes impossible to raise or lower the vanns, in a great depth of water; for these vanns being very high, are greatly pressed against their grooves, tho' supported by the lower inundation. I here suppose the common vanns, because they are subject to less inconvenience, than those of a more complicated construction.

*Secondly,* The superficies of the inundation must be regulated by the shutters, and the river must fall entirely in a cascade. It is easily conceived what the floor must suffer, by the continual pressure of such a body of water, as well by its weight, as its whirling, and the mud which will be gathered there.

*Thirdly,*

*Thirdly*, Finally these sluices are commonly founded in clay; But as liquids press in proportion to their depth, the least filtration between the earth and floor, increasing every moment, may blow it up. The cill indeed is more secure, because of the dovetail'd piles, which should be drove before and behind it.

These sluices serving only to retain and drain off the water, and not to keep it at a determin'd height, have no occasion for vanns. Two rows of piles, distanced from each other in proportion to their height, serve for, and form with the checks, a coffer, which is fill'd with earth well ramm'd, or with clay. This batardeau secures the front piles, which it supports, and the floor which it bears on; we have thus nothing to fear from cannon. As to the superfluous water, it is discharg'd by such a reservoir as I have mentioned.

I shall say nothing here of the different ways, which according to time and means, we may turn the old sluices of this kind, into reservoirs and dischargers; because I reserve that detail, and the different works which I here only hint at, for a particular treatise on their construction.

VIII. Having thus shewn my opinion on the different methods of covering lines by inundations, I will here remark the principal difficulties attending, and the means I would recommend to surmount or avoid them. The construction of dams is subject to two inconveniencies; their multiplicity caus'd by

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the



the great fall of the ground, shall be the subject of this article.

These dams made of earth (for those I promised the construction of, will be of no use here) are, as I have already remark'd, as many bridges for an enemy, and consequently an annoyance and fatigue to an army to guard them. The only remedy I know of for so essential a defect, is to make them only at all those places, which are designed for posts, because this decreases their number, and to make them as high as possible with prudence. If there are sluices in the river, there will be found an advantage, which perhaps does not present itself at first view.

Suppose the river five feet deep; if the checks of the sluice are only rais'd 9 feet, it is evident they will throw but 4 feet water on the meadow. If there are four sluices following each other, and distanced so that each supports these 4 feet of water, there remains two below the foremost dam, which is the least that can be to hide the bottom of the river and prevent its being fill'd up; I say that one sluice only of 15 feet high, will be of more effect than those 4 of 9 feet each, and which taken together are consequently higher by 21 feet.

This difference happens from the great sluice being only once hid 5 feet in the river, and throws alone 10 feet water over the meadow.

The

The little ones on the contrary being repeated four times, lose 20 feet, which gives 15 feet difference. The 6 feet remaining proceeds from this, that except the last, each of these sluices only supporting 2 feet more of water, than that following it, there are three which lose 2 feet each. Another advantage of the great sluice is, that it throws 2 feet more water between the first and second small ones, 4 feet more between the second and third, and 6 feet more between the third and last.

Dams, sluices, or reservoirs raised on the meadow have entirely this last advantage; but it is not near the same with respect to their difference in height, because of the 5 feet the depth of the river, which is only once reckon'd; so that by the same supposition, 10 feet will produce the same effect as 16. The profile will explain what may appear obscure in this article. The thickness of these dams, increasing in proportion to their height, certainly require a greater quantity of earth; but they diminish the number of sluices and reservoirs, and, what is more essential, there are fewer bridges to guard.

If I suppose these retainers of this height, it is only to make this proposition more intelligible; for being only necessary to have them of timber and clay, and not of masonry, which is too solid for field work, I would not have them exceed 12 feet: this will even be too much for sluices with vanns; but to

prove that those I propose are capable of that resistance, it is sufficient to recollect that their coffers make them real dams, and tho' they are 12 feet high from the floor, they have not 12 feet of water to support, there being but 5 feet difference between the upper and lower inundations.

When the valley is to be overflown, the lower sluice is shut first, and when the water is risen to a proper height the next is shut, and so on; otherwise the water wou'd not be of the same height in all places.

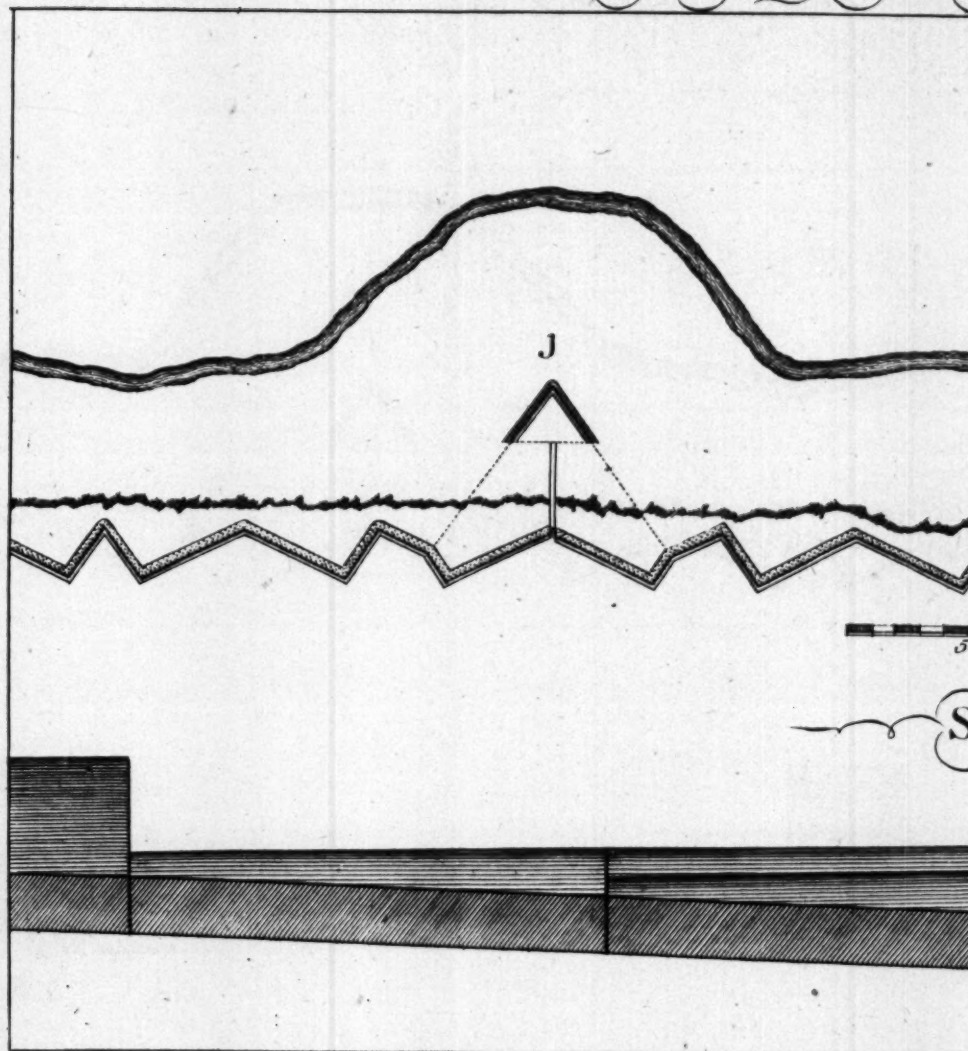
IX. The excessive lengths of the dams, caused by the distance of the places proper to support their extremities, form the second inconvenience.

Pl. XXVI. As the protection of these works is a very  
Fig. 1. material point, they must be rais'd in the narrowest part of the valley, that their heads may be defended by the line, as much as possible. As this advantage cannot always be obtained, if it be 60 or 80 fathoms distant, a lunette must be constructed to hold at least a hundred men, and turned so as to be flanked by the retrenchment.

Pl. XXVI. But when this distance exceeds 80 fathoms,  
Fig. 2, 3, the surest way, I think, is to raise a redout on  
4. the inundation itself, or breast works, 30 or 40 fathoms from the opposite side, which may cross the dam: the opening next the enemy must be covered by a turning traverse. This must also have a lunette, which only  
serving

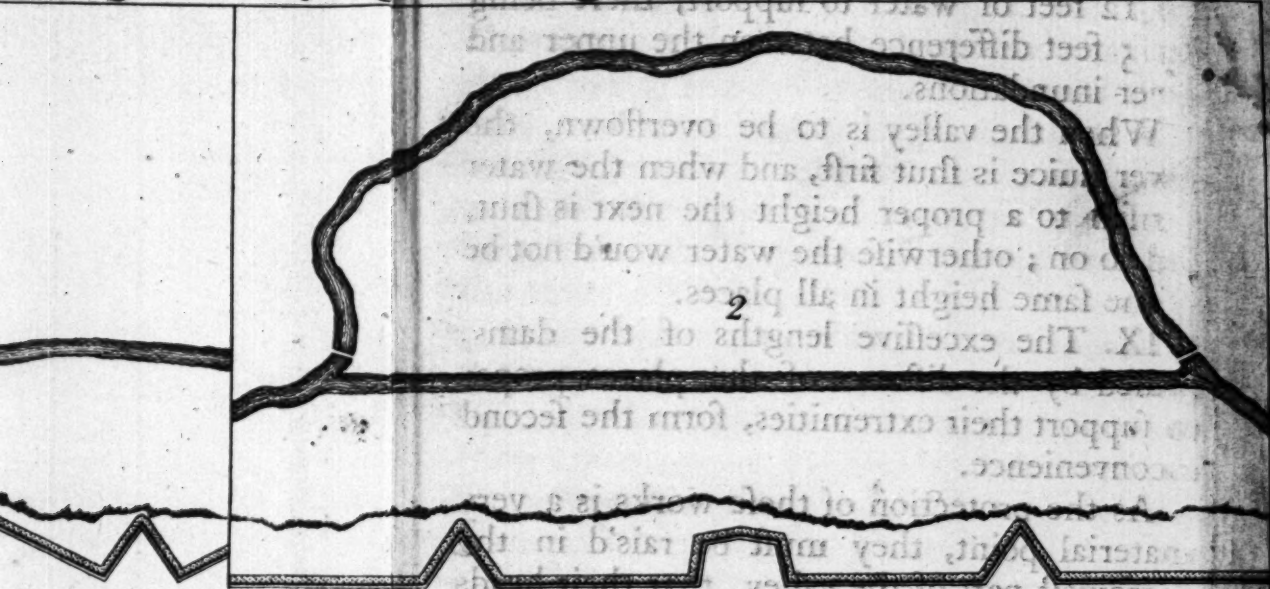


LINES COVER



# COVER'D by RIVERS

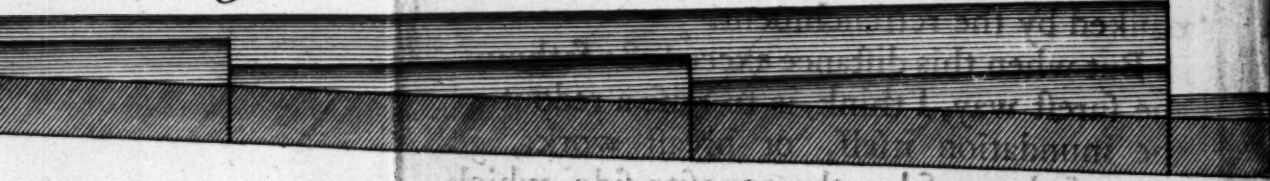
Pl. 25. p. 170.



50 100 200 Fathoms

# SLUICES

3



...to fathoms from the opposite side, which  
...cross the dam: the opening next the  
...must be covered by a turning traverse  
...must also have a lunette, which only  
...retains

... as an advanced work, or rather  
... may be much smaller than the other  
... double parapet raised on the dam  
... the communications of these different  
... at least from one piece to another  
... the quantity of earth required should be  
... The author's meaning must be, that  
... parapet is to be made only, in case of  
... of the great quantity of earth is  
... and not as it is explained above.  
... This calls to my mind, the method  
... to construct one of the dams of the Lake  
... it is an intrenchment covered only on  
... side, which by its several turns is secured  
... from embarks, and yet opposes a cross  
... superior to that from a point of land, situated  
... ing out from a hill. This work, which  
... does honour to the engineer who directed  
... shows what may be done on like occasions.  
... X. The difficulties found in covering the  
... by inundations, I think may be reduced  
... the three following cases.

First, When the ground, thro' which  
... river runs, is on a level too great an  
... rent; how can water be raised on a  
... surface, without means of confining it?  
... this is not impossible; but I don't know  
... it was ever attempted.

Secondly, When for the same reason,  
... dams are obliged to be made excessive  
... for want of nearer ground to support  
... heads, they require much work, and  
... a slope, which being liable to



serving as an advanced work, or rather a lookout, may be much smaller than the others.

A double parapet raised on the dam will secure the communications of these different works, at least from one piece to another, if the quantity of earth required should be too great. The author's meaning must be, that a single parapet is to be made only, in case the weight of the great quantity of earth is too much, and not as it is expressed above.

This calls to my mind, the method taken to construct one of the dams of the *Loutre*. It is an intrenchment covered only on one side, which by its several turns is secured from enfilade, and yet opposes a cross fire, superior to that from a point of land, stretching out from a hill. This work, which does honour to the engineer who directed it, shews what may be done on like occasions.

X. The difficulties found in covering lines by inundations, I think may be reduced to the three following cases.

*First*, When the ground, thro' which the river runs, is on a level for too great an extent; how can water be raised on a flat surface, without means of confining it? Yet this is not impossible; but I don't know that it was ever attempted.

*Secondly*, When for the same reason, the dams are obliged to be made excessive long, for want of nearer ground to support their heads, they require much work, and posts in front; which being liable to be attacked

at a time when darkness renders the defence drawn from those in the rear weak and uncertain, give poor encouragement to officers charged with such posts.

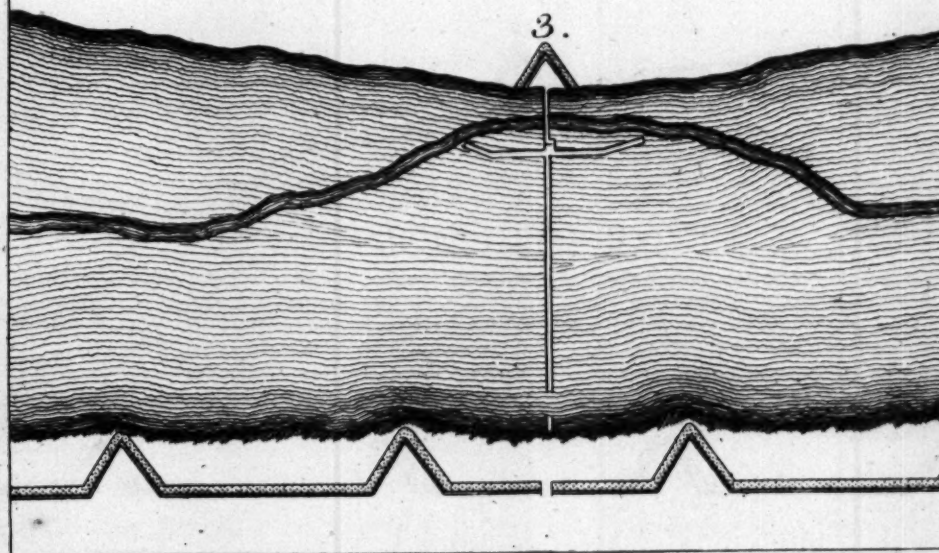
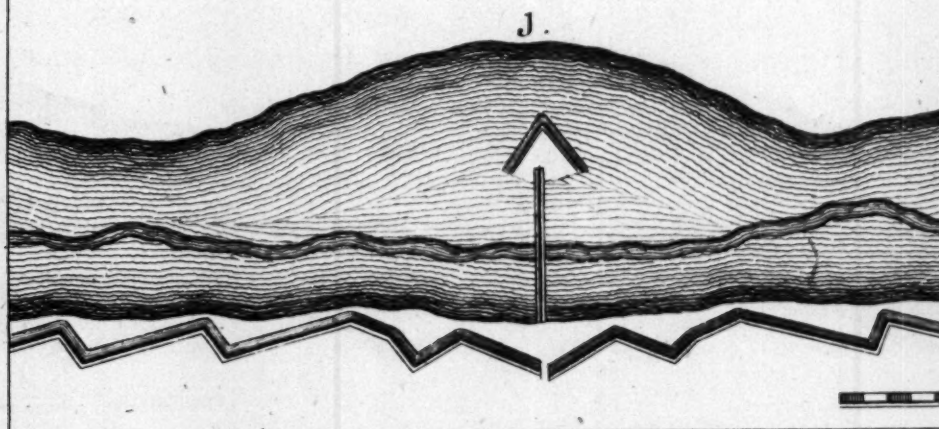
Lastly, when the great fall of the river renders it necessary to multiply the dams, which (without reckoning the increase of workmanship) are so many bridges to guard, they must of course be carefully watched.

I have shewn what is commonly done in each of these cases, but if I was charged with such an undertaking, I would avoid these obstacles, and go quite another way to work.

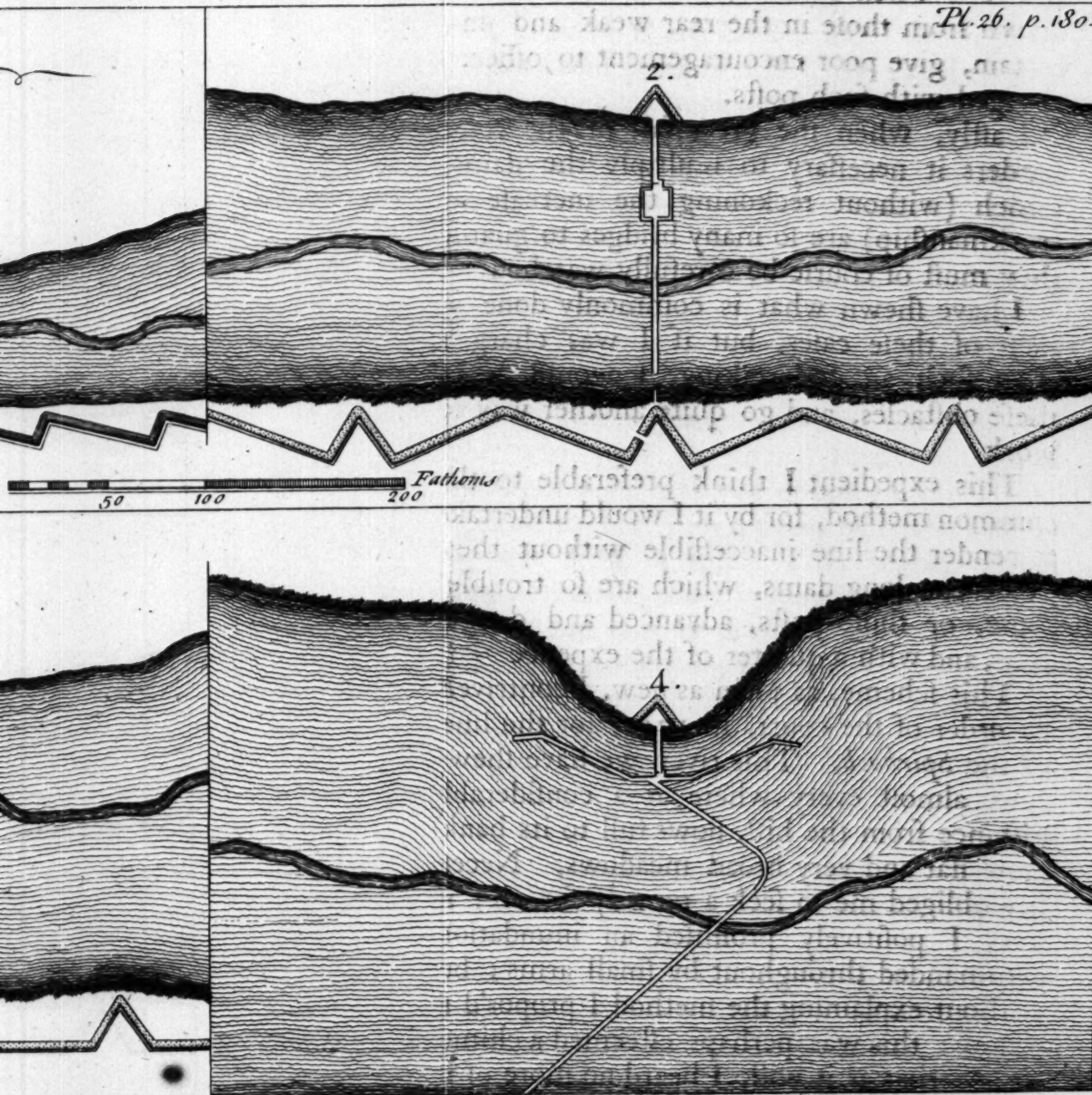
This expedient I think preferable to the common method, for by it I would undertake to render the line inaccessible without these sluices, or long dams, which are so troublesome, or those posts, advanced and dangerous, and with a quarter of the expence.

This scheme, as plain as new, I contrived, by order of the court, in 1735, for the lines of the *Spirbach*. This river we have shewn runs almost every where at a considerable distance from the hill, flows full to its banks thro' flat and very broad meadows. Necessity obliged me to seek a remedy for all; in fine, I positively promised an inundation, commanded throughout by small arms; but without explaining the method I propos'd to follow: this was perhaps esteemed a chime-ra; be that as it will, I heard no more of it, and a little after, two brigades of engineers were

DAM HEADS







were detached from the army, and  
with these lines. I could not with de-  
termine my scheme, as they did not de-  
of me, so that the opportunities of ex-  
ing it at the camps of the Lewis, and of  
wards in 1743, not taking place. I new-  
roduced it, nor even committed it to  
ing; however, the publick may judge  
the following, if it has any other merit  
novelty.

XI. I suppose all the above difficulties united  
is to say, the valley quite level and of  
great breadth, which, according to the com-  
mon method, renders all schemes impractic-  
le, and the river flowing full to its banks,  
has only 4 feet depth and a feet fall in two  
fathoms.

My method leaving me at liberty to pre-  
the what breadth I please to the inundation  
I will examine what is the most advan-  
ageous; if it is too narrow, it is not a full  
sufficient obstacle to an enemy; if too wide,  
is badly defended, and the dams extending  
in proportion require more work. These  
things considered, I determined its breadth  
between 40 and 60 fathoms.

I trace the side 60 fathoms from the cor-  
ners and other principal lines of the in-  
renchment, observing in those places where  
the rising, and consequently the fortification  
winds, to follow those only of a great extent  
and to contract the breadth before the en-

were detached from the army, and charged with these lines. I could not with decency propose my scheme, as they did not demand it of me, so that the opportunities of executing it at the camps of the *Loutre*, and of the *Queich* in 1743, not taking place, I never produced it, nor even committed it to writing; however, the publick may judge by the following, if it has any other merit than its novelty.

XI. I suppose all the above difficulties united, that is to say, the valley quite level and of a great breadth, which, according to the common method, renders all schemes impracticable, and the river flowing full to its banks, has only 4 feet depth and 2 feet fall in 100 fathoms,

My method leaving me at liberty to prescribe what breadth I please to the inundation, I will examine what is the most advantageous; if it is too narrow, it is not a sufficient obstacle to an enemy; if too wide, it is badly defended, and the dams extending in proportion require more work. These things considered, I determined its breadth between 40 and 60 fathoms.

XXVII.

I trace the side 60 fathoms from the curtains and other principal lines of the intrenchment, observing in those places where the rising, and consequently the fortification winds, to follow those only of a great extent, and to contract the breadth before the others, that is to say, to run out from 40 to 60 fathoms,



thoms, according to the greater or less projections of these parts; because the more it approaches to a right line the less extent it will have.

Six feet within, trace a parallel ditch from 15 to 20 feet broad above, and from 4 and a half to 6 feet deep, according as the water will permit: the earth dug up will form the dam made lengthways to support the inundation, preserving 6 feet for a berm, and this dam is stopped so as to leave no cover for the enemy.

If I have no wheelbarrows, I make another ditch parallel to this at the foot of the intrenchment, which in this case follows its windings; if not, it must be contrived that the scarp may be seen throughout from the parapet.

The breadth being thus determined, I trace the retainers at every two feet descent, that is, according to the supposition, one at every 100 fathoms. These retainers are formed over the whole breadth of the meadow by dams of earth, and over the ditches by batardaux's of wood; the reason of this difference will presently be seen.

The dam on the side begins at 3 feet height, and ends at 5; that which crosses the meadow, supposing the basin level, is raised very where to 5 feet, tho' it sustains but 4 feet water in the deepest place, which is sufficient to leave 2 feet at the foot of the upper retainer;

tainer; but this foot is also necessary to prevent the water from overflowing.

The earth for the dams of the retainers is taken from a ditch dug above, and as deep as those to which it communicates at the extremities; leaving 6 feet berm at least between the foot of the dam and the scarp of the ditch, whose slope must be equal to its height at least.

The dam batardeau adjacent to the side of the inundation must be made so that it cannot be walked over; and as it cannot be wasted by the water, it may be level with the surface; it will likewise serve as a reservoir in case of need. How a batardeau can serve as a reservoir is not possible to be understood; excepting the author means, it serves to make a reservoir in case of need.

The other is of a different construction; a single vann in the middle, without any more expence, will have the same effect as a sluice, which costs much more; this vann, being raised, will fill the ditches, which communicate with each other, in a little time, by closing the vann, and throwing the river into its old course, it will serve as a reservoir; in short, when an inundation is to be made, some planks, slipped into the grooves, will support it to a determined height.

The only objection I know, that may be made to this method, is the loss of water caused by filtration thro' the lateral dams. This does not appear probable to me, as they are

are very low and thick; but supposing this filtration, it can be no inconvenience, as we need never want a supply of water from the river. If it is feared that the vanns are not sufficient, the ports of the dam, which form the reservoir, must be lowered by some inches, however, so as that they are higher as they descend with the stream; the consequence of securing the entrance of the water is manifest, since it is upon this the whole depends.

This method is equally good to cover lines entirely by inundations, and to correct the defects of those already constructed after the common method.

#### OBSERVATIONS on the ninth chapter.

As there are few countries without rivers or brooks, the manner of taking advantage of their courses, in retrenching camps, is here particularly considered; and as the author seems to be somewhat obscure, so as not to be easily understood, by readers who are unacquainted with these works, a more particular explanation of so useful a subject will, I hope, not be deemed useless.

He says, that when a large river runs in the front, it forms almost an impenetrable barrier, by the assistance of very few works; but as its great length cannot every where be sufficiently guarded, the enemy may pass it either above or below, and attack the camp



in the rear or in flank, as he finds it most convenient. But since the river is a sufficient defence in the front, the attention of a general ought to be confined to the securing his flanks and rear, either by works in those places, which are most easy of access, or by morasses, if there be any at hand, or in general by all possible means, that nature and art can afford: but if the enemy crosses the river with an intention to hem him in on all sides, the general must know whether his camp can be forced or not; if not, whether he has means to subsist his army till the enemy is obliged to retire.

If a river is not very large, and its course may be carried round the greatest part of the camp, or has a considerable bent, such a situation is certainly very favourable, provided the ground on the opposite side does not command the works of the camp; it is likewise very advantageous to have a sufficient quantity of sweet water so near the camp, that the enemy can by no means cut it off, for the use of both men and cattle; for all other necessaries but that may be transported from other places.

If a river is so small as to be easily passed, dams may be made at proper distances, so as to raise it higher; or if the situation is favourable, an inundation may be formed, of such an extent, as not to be crossed without the utmost difficulties. But in both cases, great care must be taken to prevent the enemy

enemy from cutting these dams, and to let out the water; for which reason strong guards must be placed near them, and secured either by a good redout, or any other such work, as the nature of the situation will admit.

If there is a rising ground within 60, 80 or 100 fathoms of the river, the camp must be placed upon it, and an inundation formed, if it can be done between the river and camp: but when that distance is too great for such a work, two ditches may then be made nearly parallel to the rising ground, and within 40 or 60 fathoms from each other; these ditches must be crossed by two others, so as to bring the water from the river into the former; or if the ground between is low, to form an inundation. The reader must be sensible, that the whole security of such a work depends intirely on the well guarding the dams which keep up the water; for if they are not, the enemy may pass them, being so many bridges ready made, or demolish them, just as he finds it most convenient.

When the water of a river is to be raised to any moderate height, the author prefers a single dam of a sufficient height to three or four small ones: thus if the water requires to be raised 10 feet at the lower end, and the banks are 5 feet, he prefers one dam of 15 feet high to four of 9 feet, placed so as to raise the water to the same height above. His reasons are, that the height of the four dams  
amounts

amounts to 36 feet, and therefore the difference between this and 15, the height of the one, is 21 feet; and the four require four guards instead of one, which fatigues the army. How it happens that the four raise the water no higher than the one, is thus made out; the first or lowermost will raise the water four feet above the bank, and as two feet of water above the bank is reckoned the least that can be allowed to hide the bank, the second is placed where the height of the water is two feet above the bank, and therefore can raise the water but two feet higher; and the third and fourth will raise the water no higher for the same reason; so that the lowest raises the water four feet, and the three others together 6, which makes 10 feet in all; and is the same as one of 15 feet sunk 5 into the river.

To shew how much the work of the four at 9 feet high exceeds the one at 15, it must be observed, that the pressure of water against a perpendicular surface is equal to the weight of a triangular prism, whose height is equal to the breadth of the river, and the base and posales right angle triangle, two sides of which are equal each to the height of water. Now since the height of these prisms are the same, viz. the breadth of the river, and their bases similar triangles, and these similar triangles are as the squares of one of their sides, the total pressures are to one another as the squares of the heights of the water :



water: and as the solid content of these dams must be proportional to the weights they support, the quantity of the work in a dam of 15 feet high is to that of one of 9 feet high, as the square 225 of 15 is to the square 81 of 9: and as there are four of 9 feet high, and 4 times 81 makes 324, the quantity of work in the one is to that in the four, as 225 is to 324, or as 75 to 108; which is not so great a difference as might have been expected. This is upon the supposition, that all the dams support a quantity of water proportional to their height, which is not here the case; whereas it should only be the difference between the height above and below each dam; and as this difference is only two feet in the three upper dams by supposition, if therefore we subtract 3 times the square, 49 of 7 which is 147 from 324, the difference will be 177, and hence the work in the one will be to the work in the four, as 225 is to 177; or as 75 to 59; so that in reality the four require less work than the one; or at least no more; because the foundations ought to be considered.

There are other reasons to prefer four dams of a less height to one of a greater. For it is not always practicable to make but one dam in a river, so as to keep up the water to a certain height above the camp. Since, if the ground is flat to a considerable distance, the water by overflowing will spread so much below, as to prevent its rising

sing above. Another disadvantage attends a single dam, that if it should break either by a sudden swelling of the water, or by the want of a sufficient solidity, it will be much more difficult to repair it again, than any one of the four. In order to find the dimensions of a profil of a dam, supposed to be of the same form as is represented by fig. 34, plate 19. of our elements of math. whose base of the slope being one fifth of the height, we must consider, that common earth is nearly twice as heavy as common water, and by following the same steps as we did in art. 510; by supposing  $n = .2$ ; and take  $w$  for the whole weight instead of two thirds, we shall find the thickness of the profil above to be .22 parts of the height. Thus if the height be 9 feet, then 9 times 22 gives 2 feet nearly; but if the height be 15 feet, then 15 times 22 gives 3.3 feet, or 3 feet 4 inches, for the thickness above; if to which we add 3 one fifth of the height 15, for the base of the slope, we get 6 feet 4 inches for the base of the profil. It is supposed, that the case of the dam is made with boards, stakes or fascines, to prevent the water from washing away the earth.

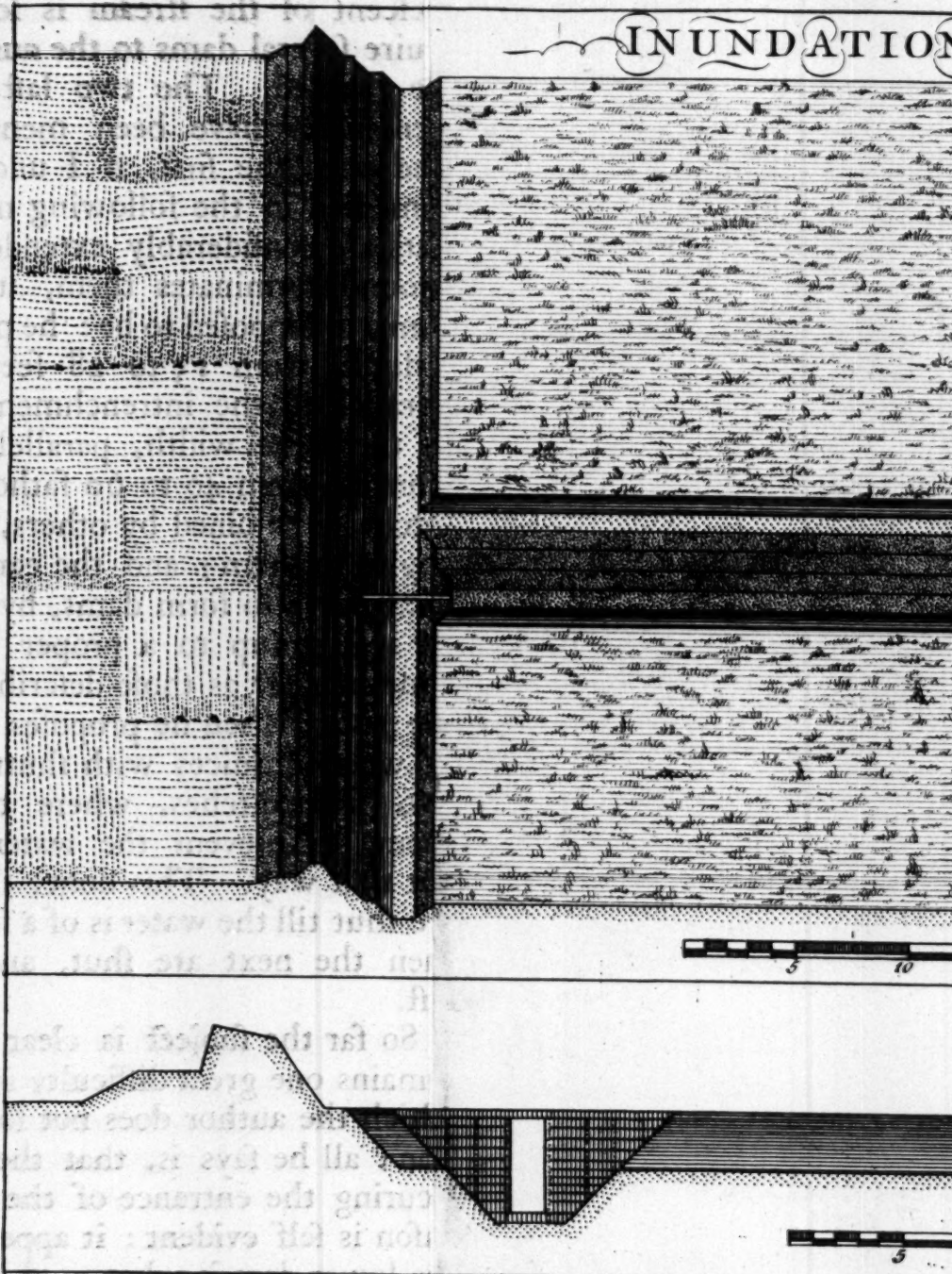
The author reduces the difficulties of securing lines by water to three, viz. when the low ground is of too great an extent, to form an inundation, to the great extent of the works which attends it; and when the descent

descent of the stream is so great as to require several dams to the number of posts to be guarded. The two last of these inconveniencies have been mentioned already; and as to the first, if I understand him, is remedied in the following manner. If the flats are considerably extended, and a rising ground terminates them, upon which the camp is supposed to be: he proposes to make a ditch, from 15 to 28 feet broad, nearly parallel to the intrenchment; and another of the same width, parallel to and distant from it, from 40 to 60 fathoms: these two ditches are joined by others, nearly at right angles to them; and the earth taken out of them serve to form dams, by which the water is kept up to a proper height, in the same manner as those described above do in the river: then he proposes to make a kind of wooden sluices with shutters, across the two first ditches, where the dams meet them, to prevent the water from running out that way. This done, the lower sluices are shut till the water is of a sufficient height, then the next are shut, and so on to the last.

So far the subject is clear; but yet there remains one great difficulty in the execution, which the author does not so much as mention; all he says is, that the importance of securing the entrance of the water into this basin is self evident: it appears to me, that the lower dam is what must be well secured,  
and

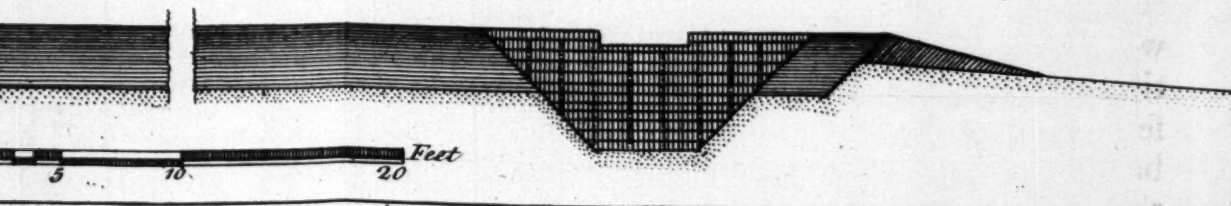
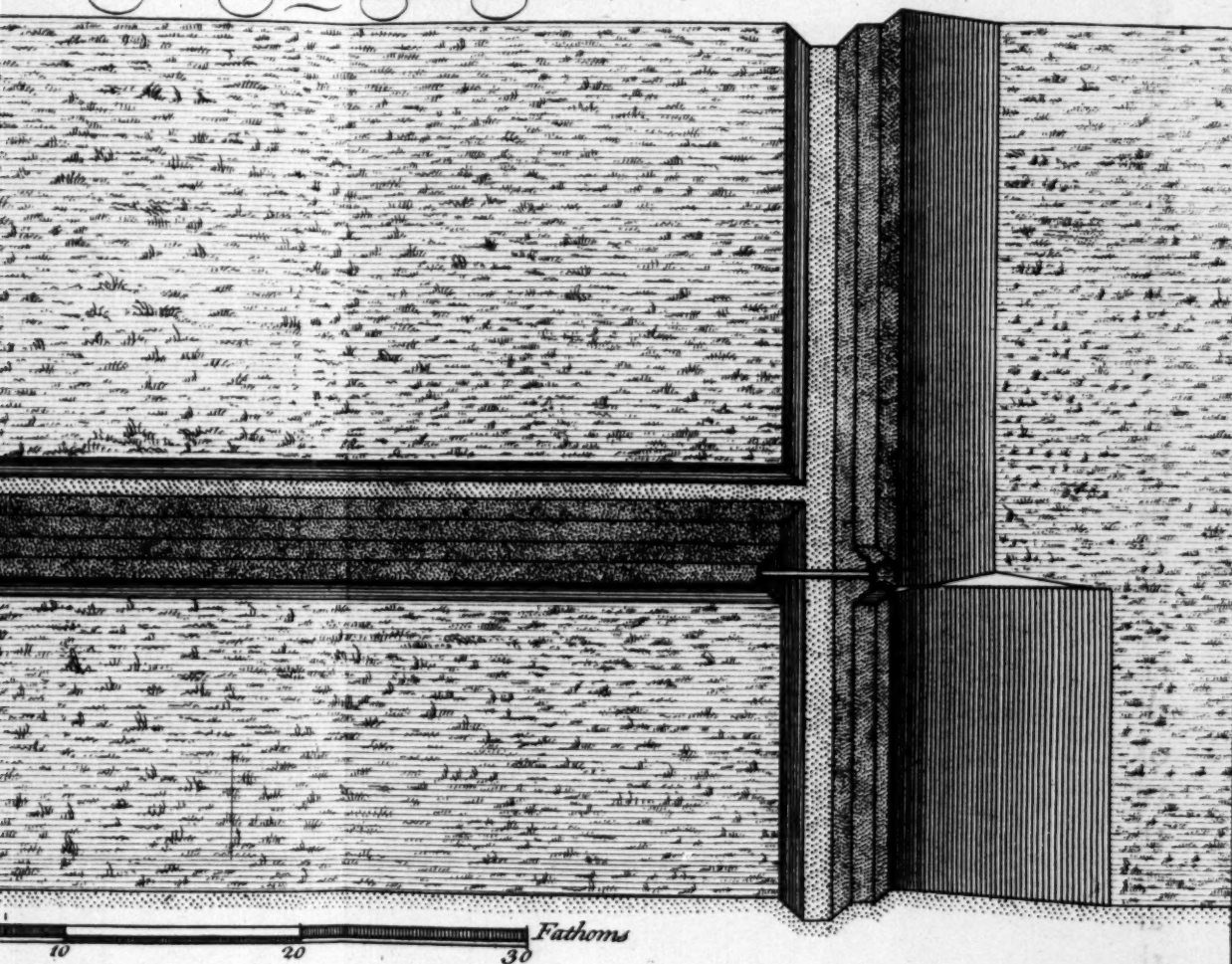


# INUNDATION



# CTIONS in FLAT GROUND

Pl. 27. p. 183.







and not the entrance of the water ; or else by cutting a passage through it, the water will run out of course. As to the guarding the entrance of the water it is not material when the inundation is once formed, which must be done before the enemy can prevent it, otherwise it is impossible to make such a work when he is once near at hand ; and to prevent the cutting the lower dam, I can see no other remedy, than to make it where the river runs so near the intrenchment, as to be defended from thence by cannon ; for the defence of small arms is insufficient, since the enemy may bring a greater against it. Nothing more can be said to it, than that a good engineer, who is upon the spot, may consider, whether such a scheme is practicable or not.

## CHAPTER THE TENTH.

- I. *Intrenchments to be made in case of a river.*
- II. *Plans of works to pass it by open force.*
- III. *To repass it in the presence of an enemy.*
- IV. *Another scheme.* V. *Example of the camp at Nordheim.* VI. *Precautions to be taken to prevent the passage of rivers.*
- VII. *Remarks on M. de Folard's epaulements.*
- VIII. *Continuation of these remarks, and schemes of the author.* IX. *Other schemes of M. de Folard.*

**T**HE various operations a general may be obliged to undertake to pass or repass a river, or dispute the passage with an enemy, require the construction of many different works, which shall be the subject of this chapter. These works are seldom of so great extent, as to be ranked with lines, yet as their figure resembles them more than any other, I thought they could not be better placed than following intrenchments covered by rivers or inundations.

I shall speak of the works alone, avoiding as much as possible to enter into the various circumstances relating to the motions of troops; in order not to depart from my subject, or to repeat without necessity what noted authors have wrote; for tho' scarcely any thing has appeared on the kind of fortification I have here undertaken, yet it is not the

the same with the other; since it has been so copiously treated, as to leave no room for any farther improvement.

II. When a river must be passed by open force, whether it be done by natural fords, or the means I shall speak of have rendered it practicable, whether by boats, on floats, or swimming, it is always absolutely necessary, that so soon as the first troops have passed over, and began to intrench themselves, to make convenient and sure communications.

If therefore bridges must be flung over; but if there was only one, a fort such as we described in chapter 2d. will not be sufficient, as not being large enough to contain the troops that must pass; the first that arrive will be straitened in the defence, or run the risk of being taken off from the counterscarp.

Besides this work, which will be sufficiently lined with eight men or less to a fathom, and where the rest of the troops must file off, a spot of ground must be found where they can intrench or barricade themselves, by fellings, or *Chevaux de Frise*, as they arrive.

This halting place, I think, cannot be better placed than on the flanks of the intrenchment, which projecting beyond them will flank them; without this, they could not have too much depth; I think there cannot be less than 60 fathoms, that the troops may not be confused by those who file off in their rear.



As these intrenchments extend in proportion to the numbers that enter, one of the extremities must be left open: M. *de Santa Cruz*, to remedy this, proposes to cross by branches the intrenchment down to the river at every 500 or 600 paces, or to supply this by a redout.

This precaution is exceeding good, but then the ground is broke, incumbered and diminished. If the river is narrow I think this additional work may be avoided, as the enemy will not be able to make an attack, without being flanked by the intrenchment on the opposite side, which before all things ought to be raised.

It is extremely necessary, if not indispensable, according to this judicious author, to construct a second bridge, when the first is finished, was it only to avoid the danger of having the communication of those that pass first cut off, if the artillery, or any other accident, should damage the first bridge.

XXVIII. The intrenchment, either entirely, or the greatest part, must be included, between the two heads; from thence results this great advantage, that if one of the bridges should be broke, the remainder of the army can march to support the work that covers it, and supposing the line finished, it is in no danger of being flanked.

The heads of the bridges have gates, because they must subsist some time, and must also communicate to the right and left, but  
none

none are made in the lines adjoining. When all the army, or at least a number nearly equal to the enemy, have passed with the artillery, if they would advance, each battalion throws down the parapet and the counterscarp before it into the ditch, so as to make an easy slope to march out in battle, and thus avoid the danger of filing off.

Thus we see what care and attention is necessary in so hazardous an enterprise; they must endeavour to deceive the enemy, to have time to raise the intrenchment and the batteries which defend the access to the bridge; this intrenchment should be favourably situated, either by superiority of ground, or an elbow in the river, which helps to cross the fires in front. *Lastly*, the troops on the other side must work half at a time, each having his arms grounded two paces before him, and the other half, prepared for an engagement, must cover them: they should relieve each other every hour, and if the enemy attack them before the parapets are formed, they must defend themselves in the ditch, where they will be covered by the counterscarp, and better assisted by the fire on the other side, which by this means they will not intercept.

III. Of all military operations, perhaps the last is the most dangerous, excepting that of repassing rivers in the presence of an enemy, where one part of the army is consequently liable to be attacked in the rear, when the other cannot assist it.

Few authors have touched on this important subject: *M. de Feuquieres* would have the troops inclosed by good lines, whose extremities, supported by the river, are flanked by the fire of some large redouts on the opposite side; that the bridges, for he supposes many, and there cannot be too many in so critical a situation, that the bridges, I say, be covered by a second intrenchment, well lined with infantry; independent of this a redan, which serves to break up the bridge with security, as also to cover the rear of the retreat,

He also recommends these other precautions, which though they do not immediately belong to fortification, may here be of use: "The light and heavy baggage, says he, should go before the army a considerable time; the cavalry also before the infantry; the first infantry that pass should be posted and intrenched on the other side, in redouts, which should protect the flanks of the army; nothing of this motion should be seen by the enemy, that they may not attac on the march, because the disorder in such a case is to be dreaded; and if the enemy are in sight of the camp, the army must march in the night only; but the second intrenchment, the redans and redouts, must first be lined; and a time chosen, when the enemy may not be able to see the motion."

On these instructions, I shall propose the fol-



following plan, tho' I do not think myself obliged strictly to follow them.

These works inclosed one within another, and consequently of different contents, are evidently designed that the troops, successively retreating, may be sufficient to line them, in proportion as their numbers decrease; for when there remains but six or eight battalions, it is certain they might be forced in that vast intrenchment, which contained the whole army; whereas they are in a state to support themselves in the heads or lunettes of the bridges; but, I find the difference of extent between the line and these pieces too great for one intrenchment.

Supposing it necessary to repass a river, when one is not master of the other side; (which is rare, and supposes the enemy much superior in numbers) to this difficult operation would be joined that of passing by open force; but as that is not the case here, the redouts *M. de Feuquieres* proposes, are only proper to secure the heads of bridges against surprises, or the danger of being attacked, before being reinforced by some light troops: a single line ought therefore to be preferred or added, because such a precaution is of use, which will form a communication from the right to the left, and flank with a greater fire every part within reach.

IV. I now come to the plan I mentioned, PL. XXIX. and which needs no description, the plate being sufficient to explain every thing. I

suppose with M. *de Feuquieres*, that we are generally freed of all our baggage, and also whatever cavalry we think we shall not want, with the infantry to line the intrenchment on the other side, passed over; this infantry may be four battalions, I here suppose six.

If it is thought these detachments would weaken the army too much, the exterior line must be put into such a state of defence, as to supply this defect before they are sent over.

This intrenchment and the works being finished, the third line begins the retreat, followed by the second, that is, by the rest of the cavalry. The squadrons are divided into three detachments, and each detachment passes over the bridge nearest to it.

This motion is made in the night, to keep it from the enemy's knowledge: yet if they should discover it, and take that opportunity to attac, which they will do in the center, to avoid the fire of the intrenchment on the other side the river, the infantry at the extremities of the line separated by the traversing lines, must abandon that post, and replace that of the cavalry in the center.

But if all is quiet, these 12 battalions file off, four over each bridge: the six battalions in column begin their march, and are followed by the 24 others, one third over each bridge.

For greater security, these bodies may be removed alternatively, that is, from two take one, that the remaining by their extent may  
be

be able to line the parapet; they may even be doubled, the battalions being supposed here six deep.

At length only the redans and the intrenchments which support them are occupied; they retreat from these, beginning by the intrenchments, and leaving in each redout within the bridge heads but two companies of grenadiers, who after having taken up or destroyed the bridges, retire in boats furnished with poles and oars, and drawn to the other side by two or three ropes fastened to each.

These redouts should be formed, by two rows of pallisades, one foot distant from each other, and if it seems necessary, with a third row of inclined pallisades.

The troops, thus successively occupying intrenchments proportioned to their numbers, are always able to line, and consequently to defend them.

They will likewise be vigorously supported by the fire from the other side of the river, the batteries of which nearly flank the line, the traverses and redans. These last pieces, and redouts, are flanked as well by the six battalions, as those who passed over, before it was necessary to defend them.

I traced the flanks and traverses indented, that the cannon might flank them the better.

Tho' this camp only supposes 60 battalions, it would be sufficient for fourscore, by replacing the 20 squadrons of the second  
line

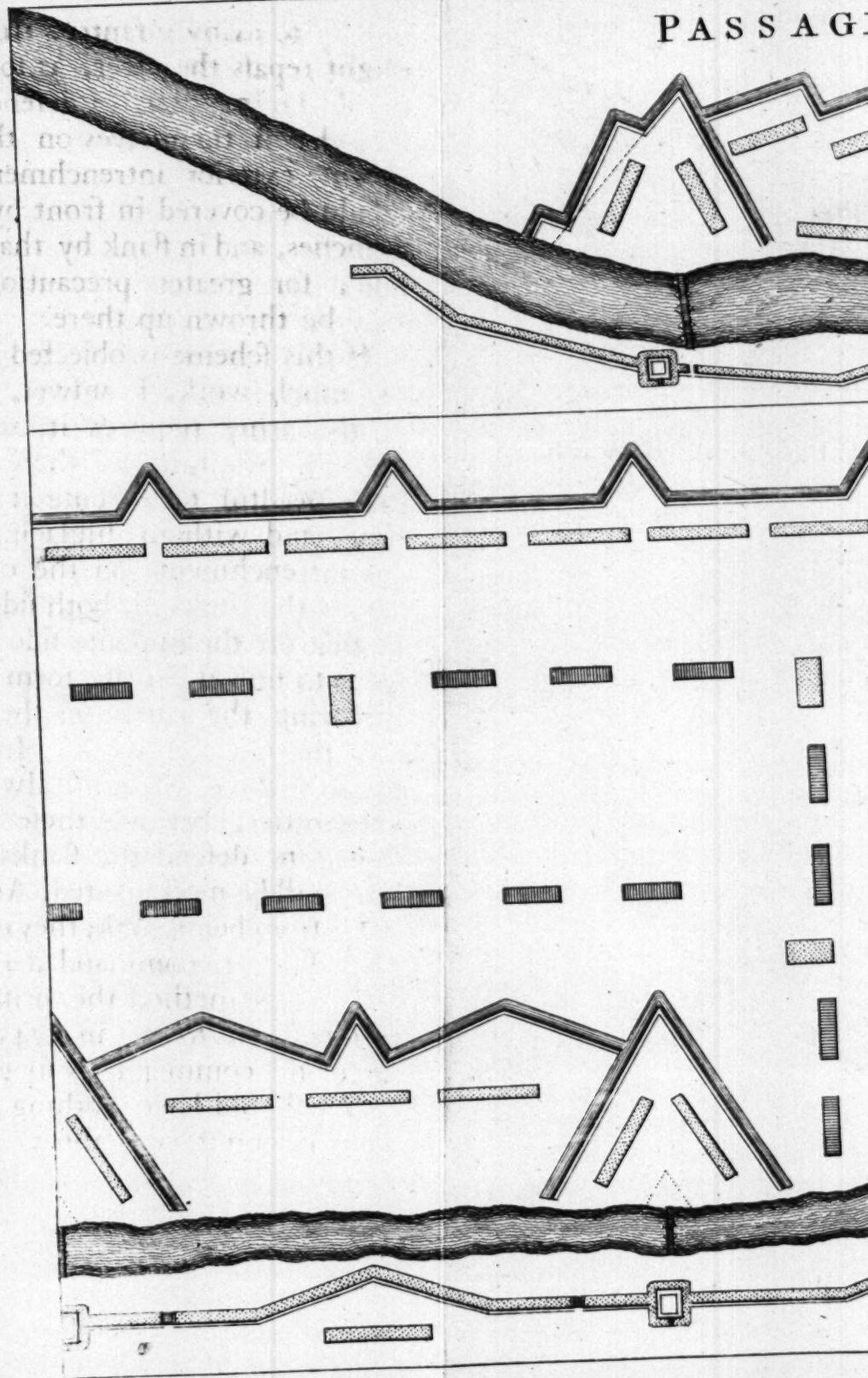


line by so many infantry, from whence they might repass the river, as soon as the works should be in a state of defence; this cavalry should post themselves on the right and left of the exterior intrenchment, where they would be covered in front by the fire of the branches, and in flank by that of the opposite side; for greater precaution some redouts may be thrown up there.

If this scheme is objected to, as requiring too much work, I answer, that the safety of the army requires it, and nothing but tools are wanting, for there are more troops than needful to execute it in a very little time, and without displacing them. As to the intrenchments on the other side the river, if the banks on both sides are on a level, or that on the opposite side high, it is sufficient to sink it in the form of a trench, by throwing the earth on the outside, which will shorten the work. In whatever manner it is done, we must always begin at the extremities, because these parts being designed to defend the flanks of the exterior line, will be most wanted. As to the batteries, so far from being sunk, they must be raised and placed so as to command at a distance in front.

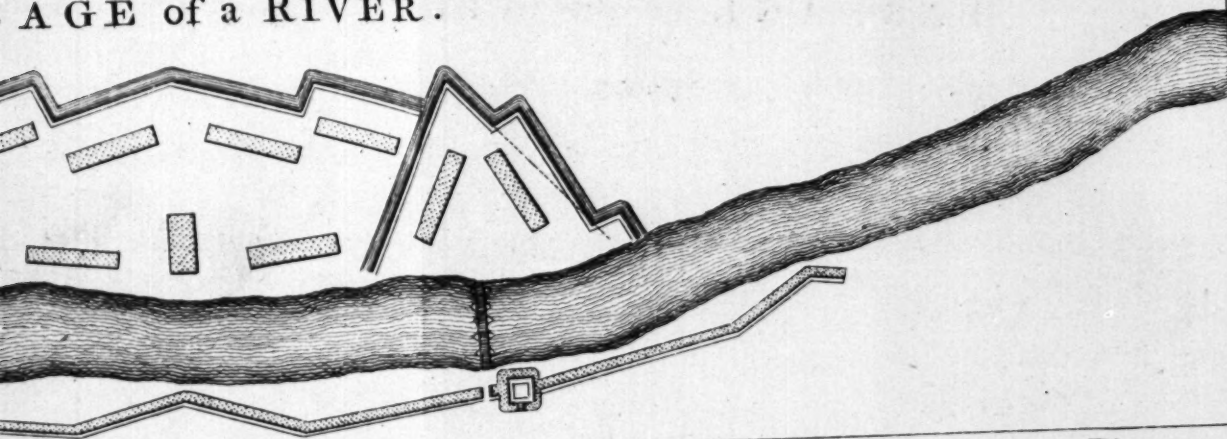
V. The method the prince of *Conti* took to repass the *Rhine*, in 1745, with the army under his command, is so good an example, that I should have nothing more to propose, were circumstances always the same. The following is a relation of the principal circumstances

PASSAGE



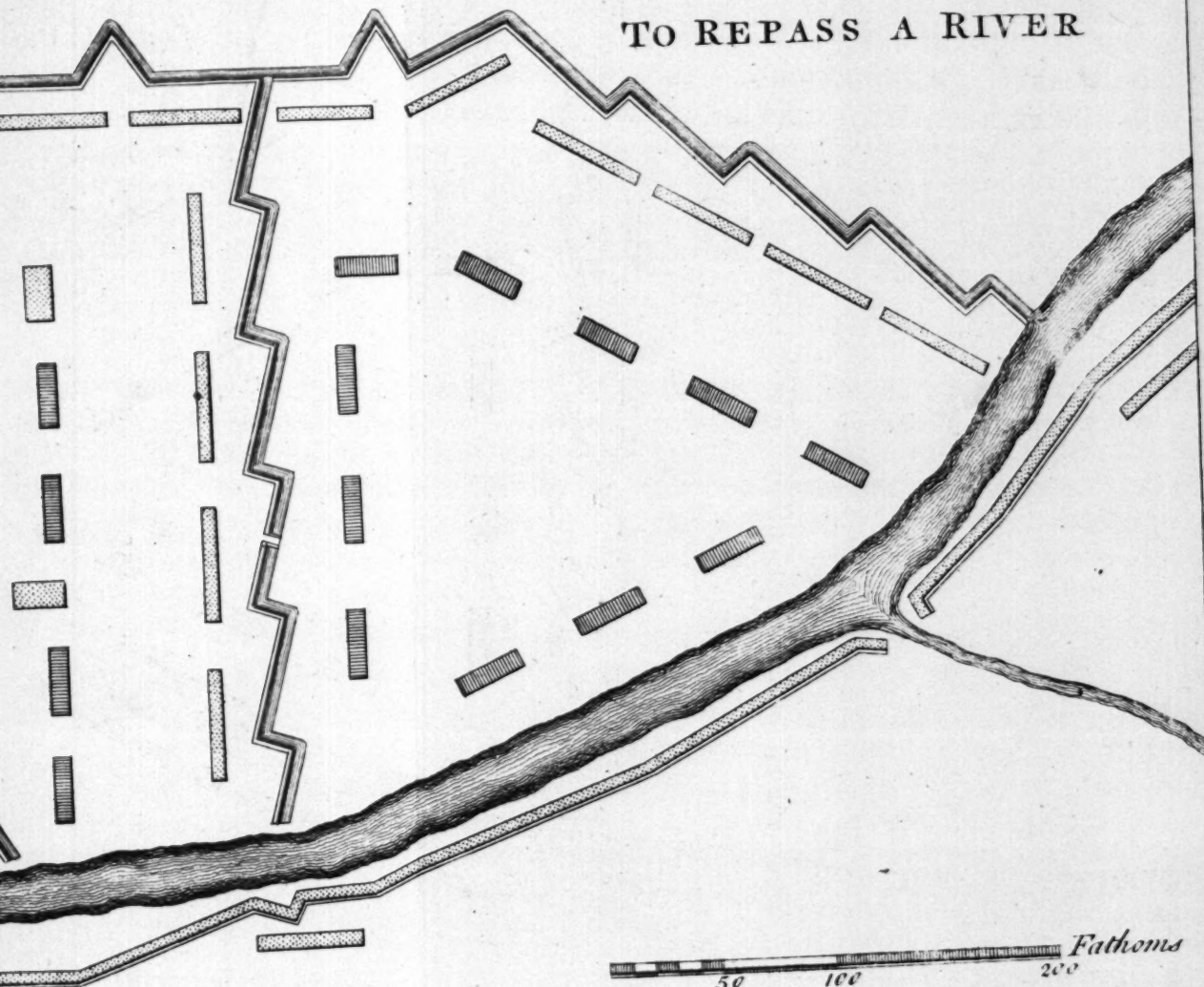
*Pl. 28. p. 196.*

AGE of a RIVER.



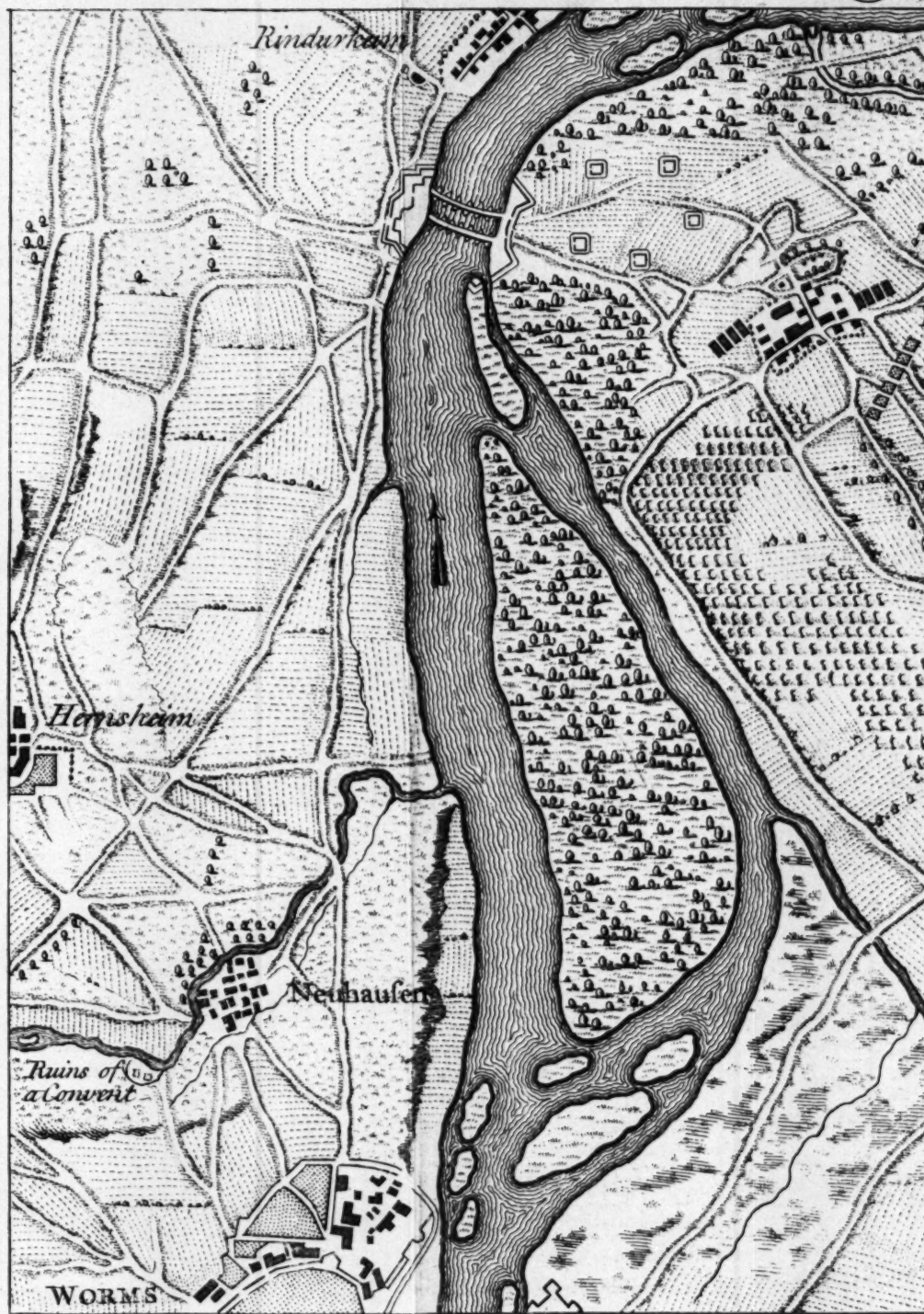
*Pl. 29. p. 199.*

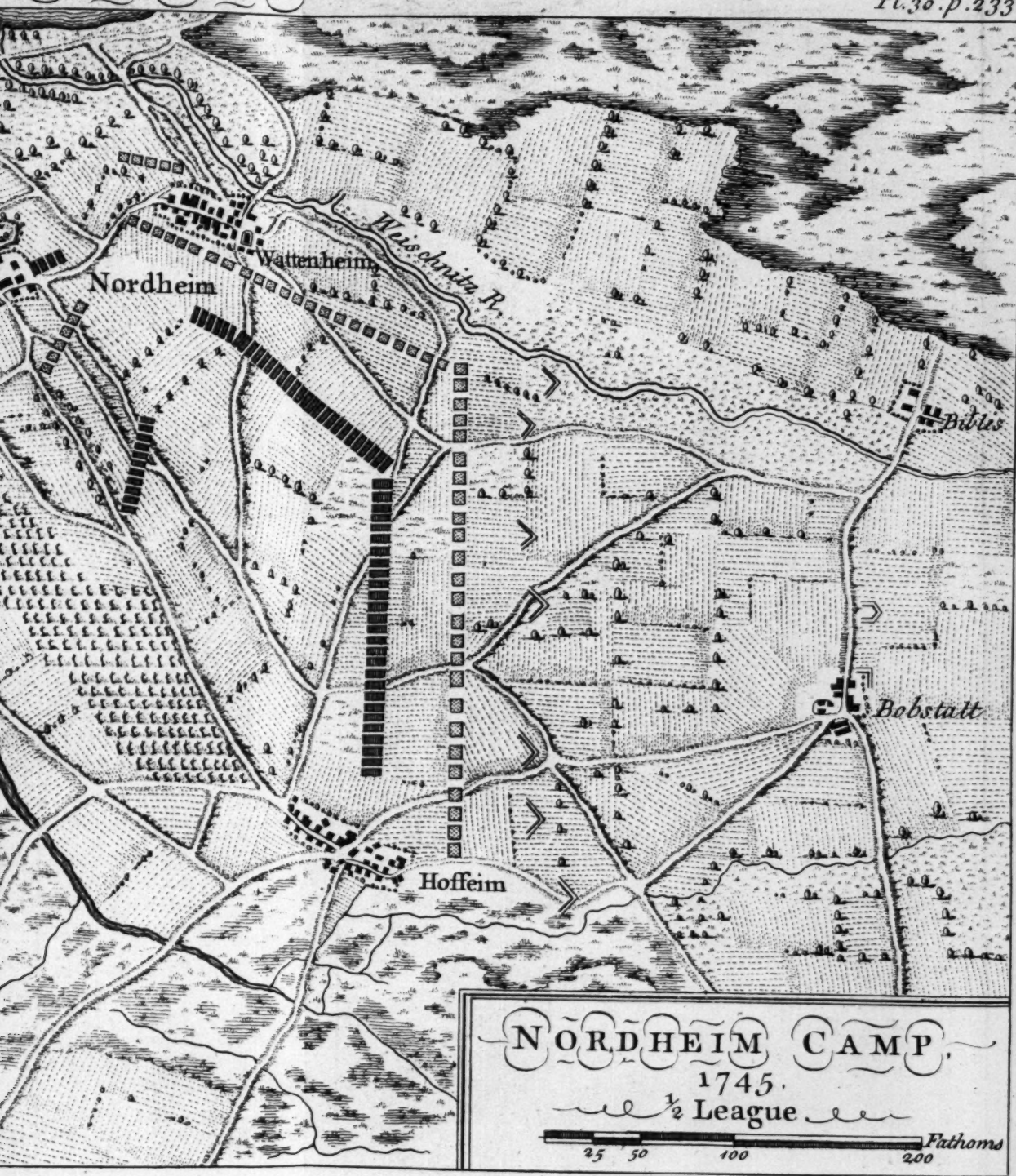
TO REPASS A RIVER



50 100 200 Fathoms







circumstances of this event, drawn up by the  
revelator & Clarke, my nephew, who was

present.  
The right wing of our army, supported  
by the river and morass of Haffum, was  
directed by redoubts, each large enough to con-  
tain a battalion; we also possessed the ad-  
vantage of position, within reach of which were  
the only openings by which the enemy could  
enter the plain.

The left, supported by impassable mor-  
asses, and covered by the little river of W.  
which was only accessible by the causeway  
and bridge of W. a large village, and  
at the extremity of the line.

While the redoubts on the right, and some  
towards Rebut were raising, we con-  
structed five redoubts at some distance from  
the ruins of the two bridges we had flung  
down below Raskum. These redoubts were  
situated, that the enemy could not pass  
until they had forced them all; which  
the more difficult and tedious to be done,  
being well guarded, they reciprocally de-  
fended each other, and could not be attack-  
ed singly, or another.

A small baggage being sent over the R.  
the works finished the day following.  
At day some troops of cavalry, on  
the front of the plain, and the independent  
battalion of the militia, and the  
brigade of the militia, and the



cumstances of this event, drawn up by the chevalier *de Clairac*, my nephew, who was present.

The right wing of our army, supported by the rivulet and morafs of *Hoffeim*, was Pl. XXX. covered by redans, each large enough to contain one battalion; we also poffeffed the village of *Bobftat*, within reach of which were the only openings by which the enemy could enter the plains.

The left, supported by impracticable moraffes, and covered by the little river of *Weifchnitz*, was only acceffible by the caufeway and bridge of *Wattenheim*, a large village towards the extremity of the line.

While the redans on the right, and fome others towards *Bobftat* were raifing, we conftituted five redouts at fome diftance from the tails of the two bridges we had flung over below *Rindurkeim*. Thefe redouts were fo fituated, that the enemy could not penetrate until they had forced them all; which was the more difficult and tedious to be done, as being well guarded, they reciprocally defended each other, and could not be attacked but one after another.

All our baggage being fent over the *Rhine*, and the works finifhed the day following at break of day, fome troops of cavalry, one regiment of huffars, and the independant companies were drawn up between *Bobftat* and the rivulet, and the infantry brigade of *Britany*, defigned for the rear-guard, were  
posted

posted in the hedges beyond *Nordheim*, after which the army, being drawn up at the head of the camp before day, began to file off in five columns, three of infantry by battalions in front, and two of cavalry; the artillery, divided into four parts, were in the intervals.

The troops which guarded the openings of *Bobstat*, being on their march, were attacked by 6000 hussars, croats, or pandours, commanded by general *Trips*, who made some squadrons give way, and falling on the rest, put them into disorder; but the whole quickly rallied behind a reinforcement of cavalry, sent from the main body, who having stopped the enemy, rejoined their column.

They were yet more unlucky on the right. Those who passed by *Wattenheim* were vigorously repulsed before *Nordheim*, and the enemy resolutely followed the troops who retired from this post, till the fire of the first redouts stopped them, and the brigade of *Britany*, facing quickly to the right about, pursued them close with fixed bayonets, and drove them back to the very village.

In the mean time the army filed off leisurely; when the main body and artillery had passed the *Rhine*, the rear-guard, and those of the redouts, which we successively evacuated, followed.

We had no more than 15 companies of grenadiers to line the intrenchments of the  
tails

tails of the bridges. They all came over except 100 men, who staid while the bridges were taken up, which was done so hastily, that the violence of the wind and current having broke the cables, we were obliged to burn some of the boats.

The bridges being at some distance from the shore, the 100 men set fire to a heap of fascines and tarred wood, which serving as a shelter, gave time to this little body to embark in the boats which waited for them.

This famous retreat, made in eight hours, without the least confusion, cost us no more than 200 men, killed, wounded and prisoners, and the enemy lost above a thousand.

There are not I believe many examples of passing an army over such a river as the *Rhine*, in broad day, with so much order, and so little loss, especially being pursued by a considerable army composed in part of light resolute troops. The choice of a camp, the possessing of all the advantageous posts, the disposition of the troops, always within reach to support each other; the artillery, redouts and works, in short the detail of many other circumstances not belonging to the present subject, prevents my saying any thing more of so skillful a general.

The five redouts, capable by their position to cover a numerous body, have in some measure the same effect as my exterior line. The bridges were covered by one work only, yet the size and figure also answered the intent



tent of the two redans and the intermediate intrenchment. The curtain was broken, because the saliant parts were so far distant from each other, as to require these new flanks; lastly, two batteries on the opposite bank defended the access to this head.

These works, much less considerable by their extent, than by their judicious disposition, were sufficient to secure the retreat of a good army, well conducted, full of confidence and courage, so that any additional works would have been superfluous; but if I may speak my mind, I believe *M. de Artus* who directed them, would not have thought them so, with an army that had been beaten, discouraged, and where consequently, it is to be feared, the most exact order is not maintained; in this case I think my scheme more agreeable.

VI. Having treated of passing rivers, I might be accused of neglect, if I said nothing of the means of preventing these passages.

Is it not a paradox to assert, that this operation is as difficult as the other? Yet it is true, if not in itself, at least by circumstances. Nothing is more difficult than to pass when an intelligent enemy opposes the passage; it is even impossible, if they lodge first on one of the banks; yet nothing is more difficult than to hinder the passage, when there are many fords, or places where bridges can be flung over; because to guard these places reduces an army to nothing; and in this case,

as

as *Feuquieres* observes, "the general, who extends his army, has the least prospect of succeeding."

The best to be done on this occasion, I think, is to throw up small redouts, not only in the suspected places, but in their intervals, and near enough each other to form a chain of centinels and patrols, and if the country is on our side, fifteen peasants is sufficient for each, who by these works will not be in danger of being surprized in the night, by parties who might cross in boats; when they discover any extraordinary motion, they make an appointed signal, which being repeated from post to post, passes in a moment from right to left, time enough for the adjacent troops to arrive: this I saw practis'd in *Alsace* during the last two wars.

When there is an island within reach, it must have troops posted in it, and some works to cover them; at least, all the wood and bushes should be cut down, that nothing may pass unseen. Had we taken this precaution at *Spire* in 1735, the imperialists could not have burnt our magazines, close to the gate of the town, with bombs and hot bullets, which by good luck were not considerable.

In prescribing these precautions, I supposed a deep river; but when it is not so every where, the fordable parts should be obstructed by every method that can be devised. If in either case there are but few

few accessible places, intrenchments must be raised on the bank before them, that the troops which march on the signal given, may enter them at their arrival.

These intrenchments always useful, are often absolutely necessary; for if the enemy come with a considerable artillery at the same time with your troops, it is probable, that not being able to sustain the enemy's fire without these intrenchments, they will be quickly obliged to quit the spot.

VII. There are so few schemes of this nature to quote, that it would be an affectation to pass by those *M. de Folard* has proposed on this subject, tho' the first does not appear to me clearly expressed.

“ The best way, says he, is to make strong  
 “ epaulements, in the form of a crescent or  
 “ curve, at 80 or 100 fathoms from the place  
 “ where it is thought the enemy can pass;  
 “ the two horns or extremities of the curve  
 “ must be 20 fathoms from the side of the  
 “ river, that they may not be enfiladed by  
 “ the enemy's cannon, and that there may  
 “ be room enough on the outside to cover  
 “ a great body of cavalry and infantry.  
 “ This epaulement should be 7 or 8 feet  
 “ high, the earth cast towards the enemy,  
 “ as we make our trenches, and it must  
 “ have a gentle slope; it is behind this little  
 “ hillock of earth, covered from the fury of  
 “ the enemy's cannon, that we wait at the  
 “ pass.”

When



When a certain number of the enemy are passed, and they begin to form in spite of this cross fire, which, as the author observes, will rake them in front and flank, “ the  
“ cavalry mount their horses, and march  
“ towards the enemy, with a grenadier behind each, whom they set down, when  
“ within a certain distance, to form platoons of 50 grenadiers each, who are to  
“ engage with them, between the squadrons.”

This last passage I do not well understand; it may be want of conception on my part; tho’ it would not be astonishing, if in so great a work, and wrote with so much spirit, an author full of his subject, should not be equally intelligible throughout.

The figure so far from explaining, rather confuses me the more, by the small depth of the intrenchment, in respect to the number of troops drawn up there, if I was not assured, that the same plate serves for two different examples.

I have nothing more to add on this, only that the depth of the curve being determined at 80, or 100 fathoms, it will be straiter in proportion to the greater body to be covered without, and the straiter it is, the less it will flank the enemy; finally, supposing even the figure elliptick, the center will only be defended in front by small arms, if the greater axis exceeds 240 fathoms, that is, double the range of a musket.

The gentle slope of the epaulement, shews plainly that the troops are to mount by that to attack, which is an excellent thought at least for the infantry, as they can make it from every part at once, and there will be one part covered by the fire of the opposite side, against that of the enemy; but in this case, of what use are the passages of 20 fathoms at the side of the river? finally, if the troops behind the epaulement, are designed to cover them, what necessity is there for advancing with the grenadiers mounted for so short a distance? it cannot be those he means, but others who are to march in order to reinforce them.

I must yet add, that it is not my fault, if I cannot give a better explanation, having applied to the author for that purpose, but after waiting a long time, without receiving the explication which he promised me, I was obliged to go without it. I say this in my own justification; for in my opinion, it is unpardonable to quote obscure passages, and complain of their obscurity, when by writing, or speaking to the author, it is easy to have them explained.

VIII. I should not be much more excusable, for referring to ideas, which I look on as imperfectly expressed, if I did not, in so doing, draw the advantages the author proposed; and which perhaps I might find there, if I understood them better.

The

The following method I think answers his designs; the curve figure propos'd, tho' little practis'd, is convenient, but it requires attention and choice. The more the curve approaches to a strait line, the easier it is to conform to an essential maxim of his, which is, that the exterior be covered throughout: besides the order of battle will be less broke, the front of the troops which must line it approaching the nearer to a right line.

The elipsis must therefore be rejected, as having parts where the curve is too abrupt; and for a much better reason the semi-circle, which besides that inconvenience, cannot be formed with a radius of 80 or 100 fathoms, (the smallest range of a musket,) as the epaulement would not have extent enough.

The first scheme is constructed on these Pl. XXXI.  
principles: it is the segment of a circle of Fig. 1.  
128 fathoms radius, and 80 fathoms for its versed sine, which determines the chord at little more than 226 fathoms.

This method is good, as the fires drawing nearer together, in proportion to the distance from the circumference, and so must have a great effect, as well on those that have pass'd, as on those that are passing; but it is not easy in practice to trace the portions of so great a circle.

For that reason, perhaps the second figure Pl. XXXI.  
may be preferred: the opening is 240 fa- Fig. 2.  
thoms; the middle line 60 fathoms long,



parallel to the river, and 80 fathoms distant from it.

This line and those of the sides being strait, the fires of each are parallel between themselves, but they cross a considerable space, (when those of the first plan, in the segment of the circle, approach and unite) which may be thought more advantageous.

Pl. XXXI.

Fig. 3.

If that is not approved of, the circular form may be approached at pleasure, by dividing the chord into as many parts as the figure is to have sides, and determining the length of the perpendiculars either by computation or by the scale.

Which ever method is followed, the most essential point is to cover the exterior part of the work, so as not to be seen from the opposite side of the river, which will be at least 400 fathoms distant from it, this is sufficient in respect to the range of field pieces, and the uncertainty of firing at so great a distance.

This cannot be done but by epaulements, whose length will depend on the figure of the course of the river; if it forms a reentrant towards you, they will be shorter, if the elbow runs from you, they become larger, we here suppose the course in a right line.

These epaulements must be so disposed, that the troops may move easily behind the extremities of the work, that the files of troops be not square with their front. It is on this maxim, that in the last plan I made

made them perpendicular to the sides. The hook parallel to the river, and also the adjacent parts on the right and left, are designed for artillery, which batters the access and the passage of the river, and the enemy's cannon almost directly.

There only remains one observation more to make, it is on the profil of this work. These gentle slopes, that the cavalry may ascend and descend, (which I believe is the meaning of the author,) would be very advantageous to draw out in line of battle; but their construction will be found very difficult, if seven feet and a half are given for the height of the epaulement, as they must have at least 30 feet base, which added to the thickness at top, makes at least 11 fathoms at the bottom, and seven fathoms and a half solidity in every fathom length; but independant of this excessive work, it is plain what trouble there will be, in throwing the earth so far, especially taking it only from one side, and how much the ditch adds to this distance and the length of the slope; besides it is obvious that the least rain renders such a passage absolutely impracticable.

The whole is remedied thus; let the part of the epaulement designed for cavalry have only the natural slope, that is a gradual one, with one or two openings of 36 feet each, and masked at an equal or proportioned distance, which will serve as a passage.

The epaulement for the infantry 6 feet high

high, and its slope, one foot and a half to a foot, that the battalions may leap over, without filing off.

Thus in one case, there will be about half, and in the other two thirds less earth to remove, and it is taken within and without, which greatly shortens the work, observing to make the excavation as broad as possible, that it may have the less depth.

The epaulements of the flanks will better guard against the ricochet, if we give them the height of the first profil, when the infantry are on the sides. They cannot be less than 8 feet high to cover a man on horseback, supposed on a level with the enemy, as I do here, and which without doubt should be taken as a rule.

IX. *Folard's* other schemes relate to those elbows, or turnings in a river, where the defendants cannot engage, without being taken, or battered in front, flank, and sometimes in the rear. They give the enemy great advantage, no doubt; but to use the author's own words, not so much as is commonly said; for these windings are, at least in part of their extent, enfiladed, and seen obliquely from the points where the curve begins.

To gain by this circumstance, he raises a redout at each of these places, capable of containing 150 men with cannon; the rest depends on the number of troops that may be thought necessary to sustain the post.

Pl. XXXI.  
Fig. 3.

If there be a body of cavalry and infantry within



within reach, considerable enough to charge those who may endeavour to force it, they are sheltered from the enemy's cannon, by joining epaulements to these works, of the kind we have spoken of, as it is pricked on the figure.

But if there is only infantry, and the number of these windings does not permit to employ sufficient forces at each, a line must be drawn from one redout to another, the middle of which is covered by a lunette, to which it communicates.

Finally, if the redouts can only be guarded, they must be so constructed, pallisaded, and defended, as at least to hold out till succours can arrive; the same must be understood of the lunette and intrenchment.

I thought to flank these redouts, and to turn them and the line which joins them, in a manner most proper to have fulfilled their design; but it is in that only, I here differ from *M. de Eglard*. We must observe, that in this, and the preceding article, he supposes the river fordable; for if it was not, less work would suffice to hinder a bridge being thrown over. His epaulements are yet very proper for this use, since if the bridge was finished, it would be useless, on account of the facility of successively beating the troops that might endeavour to pass.

#### OBSERVATIONS on the tenth chapter.

The manner of passing rivers, when an enemy is at hand or preventing an enemy

from passing, is certainly a master-piece of the art of war: it is what authors treat with the greatest care, and in the fullest manner, especially M. Folard, in his commentaries upon *Polybius*, vol. 4. And our author has taken great pains to explain it by the help of several draughts: the first plate 28, contains two bridge-heads joined by an indented retrenchment, wherein all the parts are well flanked; this example supposes an army to pass a river, when the enemy is on the same side; and as a part passes the others retire gradually from the retrenchment into the lunettes, which cover the bridges; and those who have crossed first intrench themselves, in order to cover the retreat of the last.

The example in plate 29, supposes a large army, which is not only intrenched all round from one end of the river to the other, but a part is cut off on each side by an indented retrenchment; in order, when part of the army has crossed, the rest not being sufficient to line the whole work, that they may retire in the middle part; and as the number diminishes into that part between the bridge-heads, and from thence into the lunettes which cover the bridges, whilst those on the opposite shore intrench themselves, in order to cover the retreat; but to secure the retreat of the last, small redouts are made with a double row of pallisades, within the lunettes, in each of which two companies of grenadiers are left; and as soon as the bridge is broke

broke up retire in boats, which are partly towed over with ropes, and partly by rowing. It is very certain, that this passage is as well covered as can be expected; and if the troops do their duty without confusion, it will be a difficult matter for the enemy to break in upon them, tho' equal in number. It must however be observed, that the ground must be level all round this intrenchment for 7 or 800 fathoms distant; otherwise the enemy's cannon, placed on a rising ground, would do great execution, and consequently disturb the retreat greatly; for which reason it would be very hazardous to undertake the passage in such a case; unless the cannon could be masked by a high epaulement; or having a large battery on the opposite shore to oppose an equal or superior fire to them.

The author's next example, relating to the retreat of the *French* over the *Rhine* in the face of the *Austrian* army, by prince *Conti*, is perhaps one of the finest that was made this age: as the author gives a very particular account of it, we shall pass to the next represented in plate 31, which he has taken from Mr. *Folard's* notes upon *Polybius*; the question is here to prevent an enemy from crossing a river before your face, and with open force. The best way, says Mr. *Folard*, is to make a strong epaulement in the form of a crescent or curve line, at 80 or 100 fathoms from the place where the enemy is suspected to pass, the ends should terminate within 20 fathoms of



of the shore, so as not to be enfiladed by the enemy's cannon; and the intrenchment should be large enough to cover a great body of horse and foot: this epaulement ought to be 7 or 8 feet high, and the earth thrown towards the enemy. This our author thinks is obscurely expressed, especially where Mr. *Folard* adds, when a certain number of the enemy have passed, and begin to form, the cavalry mount, and each takes a grenadier behind him, in order to form platoons between the horse. For, says he, what reason is there for mounting grenadiers for so small a distance? If I am not mistaken, Mr. *Folard's* reason was, that as soon as the enemy begins to form, no time should be lost, for fear that they might make too great resistance when once formed; for which reason the horse is to charge first, passing thro' the openings left near the shore, and which he expressly supposes not to be enfiladed; and as horse alone is not sufficient to break the infantry, he makes each horseman take a grenadier behind him, in order to form platoons, to assist the horse till the infantry can come up and assist them; so that the obscurity our author complains of, is not *Folard's* fault.

He complains likewise that the retrenchment appears too small for placing so many troops behind it; without considering it is done for a very substantial reason: which is, to leave as little ground for the enemy's forming in order of battle, and to defend the crossing

sing of the river more vigorously, both by small arms and cannon; which could not be done so well at a greater distance than a 100 fathoms. Neither is there any want of room behind, for placing as many troops as is required; since under the cover of so high an epaulement, they may be drawn up in columns, as Mr. Folard would have them to fight; besides, no spot of ground is every where on a level, and the least bank or valley is sufficient to cover more. It is plain, that the chief intent of this work is to defend the river at as near a distance as possible, and therefore any other position farther off would not answer the author's intention. The author makes a supposition, which common sense should have convinced him could not have been thought of; which is, that the easy slope made to the intrenchment was designed for horse and foot to march over the retrenchment in order of battle. Upon this supposition he gives a long detail of the quantity of earth to be thrown up, and then says, that the least rainy weather would wash off the parapet in a short time. Another very useless inquiry is made, concerning the nature of the curve line, which is most proper for the retrenchment, he rejects the ellipsis, and the semi-circle, and therefore supposes it must be an arc only; but a circular arc of so great an extent being not easily traced, he makes them in parts of right lines joined together. It is somewhat particular, that he should imagine,  
that

that the curve must be a geometrical one : for in practice, works ought to be traced without instruments, and at first sight ; and it is not material what that curve may be, or whether quite regular or not, provided it answers the purpose it is sufficient ; besides, the nature of the ground may be such, that a strict regularity could not be observed, as to the works, which our author makes at the flanks, they may be very useful, in case the enemy can flank the retrenchment.

He supposes, with Mr. *Folard*, that the inward bent towards the enemy of the river is not so advantageous in passing the river as is generally imagined. Whatever these authors may think, or say, it may be asserted, for truth, that no better place can be fixed upon than that ; for they pretend, that at the extremity of this bent their passage may be enfiladed, by redouts placed on the opposite shore ; but will these redouts enfilade the bridge, where the river runs from the inward bent in a strait line, as the author supposes in the third figure, plate 31 ? this may be the case of one in a thousand, and therefore not to be mentioned ; but for example, suppose the situation was such ; what advantage can be taken ? these redouts, being close to the shore, can the enemy not erect a battery on the opposite side of as many cannon as he pleases, and soon destroy it ; or at least draw the fire towards this battery, and abandon the bridge ? so that, unless  
it



it is supposed that the enemy has no guns, which is absurd, and the objection frivolous.

On the other hand, suppose the bent was from the enemy, Would not the bridge, and all the works made to support the passage, be enfiladed from every spot of ground on the other side? Would not then a general be highly blameable to attempt the passage of a river in such a place? If the river was strait, how would it be possible to defend the passage with any advantage, which the opposite army has not, even suppose a single redan was made to cover the bridge, before any troops appear to oppose them? After as many troops are passed as the lunette can hold, How could they propose to march out upon a small front, to relieve an enemy, who is ready and prepared to receive them, as soon as he arrives, before the batteries on the opposite shore can in that case fire upon the enemy without hurting their own troops?

It is true, the enemy may be deceived by feint marches, so far as to get to the place designed for the passage some few hours before him; but as soon as he is come up, has it in his power to raise batteries for batteries, and by that means fall upon those that have passed first with all his force, without any fear of the opposite guns.

It may then be concluded, upon unanswerable reasons, that no better spot of ground can be found for passing a river, either

either by main force, or by stratagem, than at an inward bent of the river.

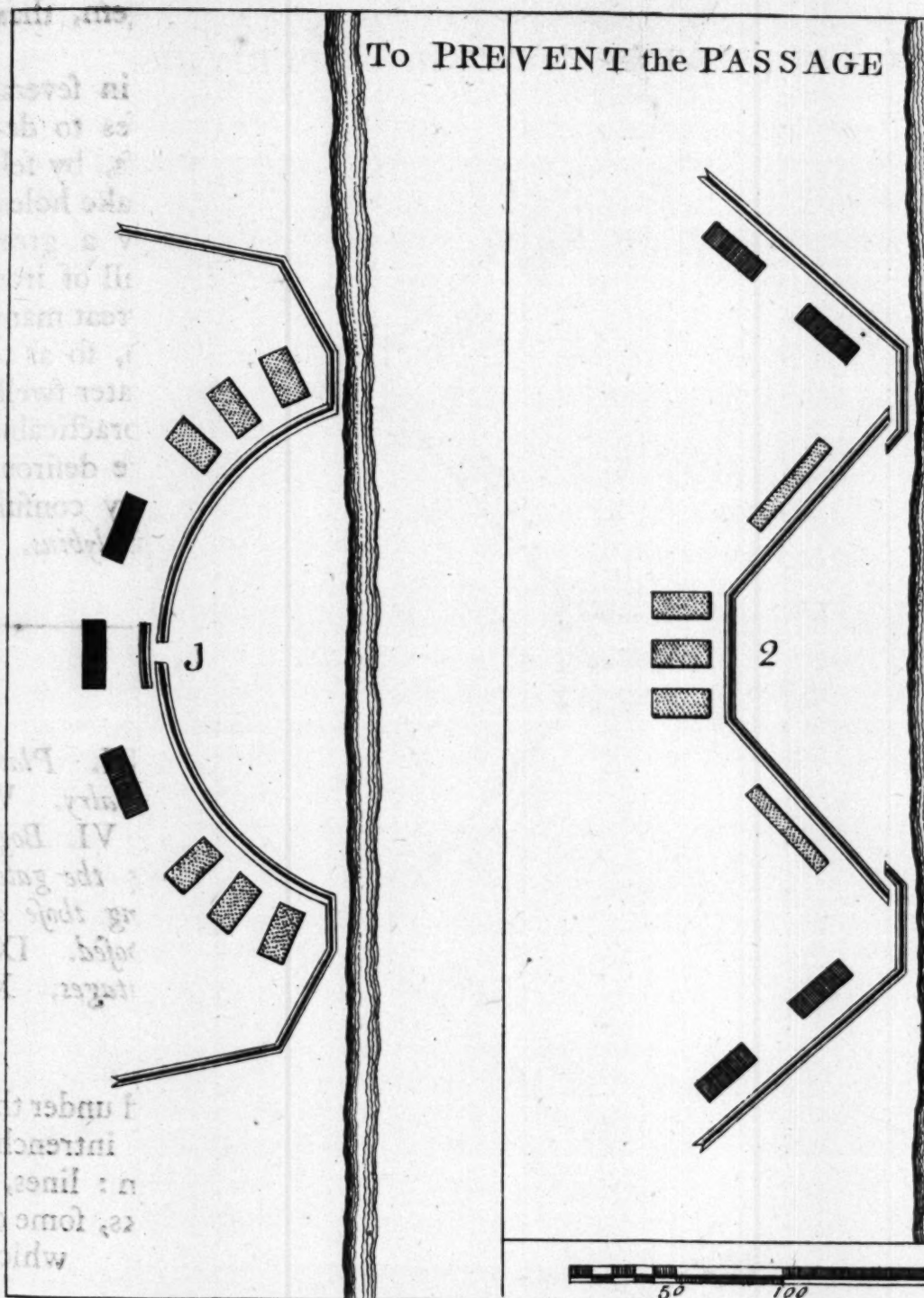
When the river may be forded in several distant places, Mr. *Folard* proposes to destroy them, or render them useless, by felling trees on the opposite side, to make holes, ditches, inundations, or to throw a great number of crows feet, or planks full of iron points, or, if possible, to throw a great many trees in them with their branches, so as to stop the current, and make the water swell, so as to render the passage impracticable without a bridge. Those who are desirous to know more of this subject, may consult his fourth and fifth volume upon *Polybius*.

## CHAP. XI.

- I. *Gates.* II. *Communications.* III. *Platforms.* IV. *Epaulements for cavalry.* V. *Schemes of intrenched epaulements.* VI. *Bog-houses.* VII. *Manner of covering the gates of common lines.* VIII. *Covering those of the different kinds of lines proposed.* IX. *Advanced ditches ; their advantages.* X. *Ravelins.*

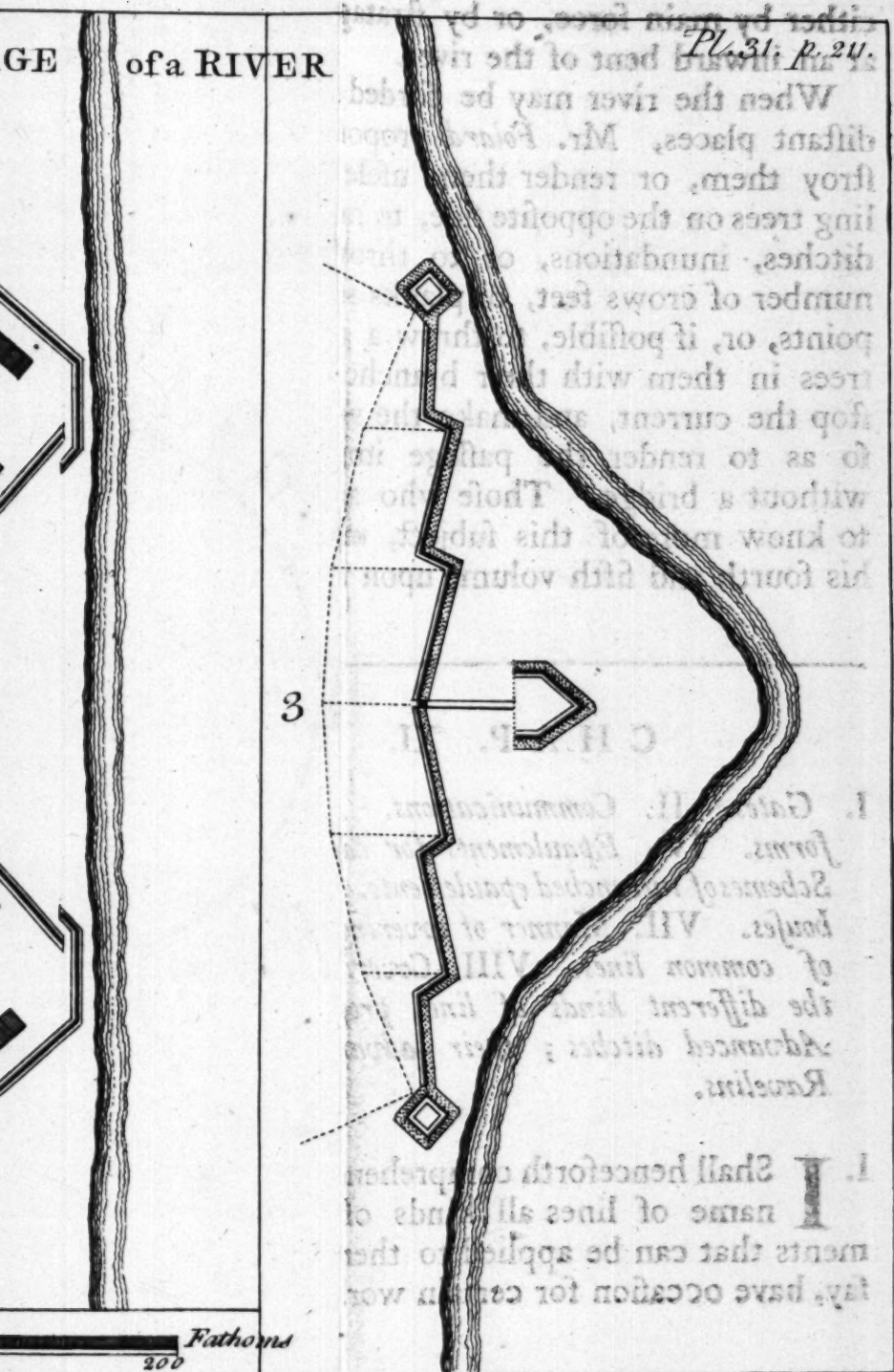
- I. **I** Shall henceforth comprehend under the name of lines all kinds of intrenchments that can be applied to them : lines, I say, have occasion for certain works, some of which

# To PREVENT the PASSAGE





# GE of a RIVER



# ENGINEER.

which facilitate the necessary movements, and others contribute to the security and convenience of the camp: such are gates, interior communications, platforms for cannon, equisements for cavalry, and bog-houses.

The number of gates to be made in lines depends on the number of troops destined for their defence, the design of the general, and the nature of the adjacent ground.

There were but few gates in the lines of the army in 1734, and they were no farther than those in the places of arms of a country. The reason of this was, I suppose, that our cavalry being sent back for want of subsistence, to the other side the Rhine, weakened us greatly, and that we had a numerous army before us, that the taking of the place was our sole object, as it was to immerse us necessarily, to prevent the overflowing of the water, which would have deprived us of all communication from one side to the other.

We may also see them for those lines, which are only accessible by few roads, or for those, before which there is not ground enough to draw up, but these different cases are exceptions to this rule.

We cannot in general have too many passages, as they are necessary in advancing or retreating; they are, as in chap. 2, the only means of abridging the time lost in falling off, and consequently of removing the defect of the army has to itself remarked.

Altho

which facilitate the necessary movements, and others contribute to the security and convenience of the camp : such are gates, interior communications, platforms for cannon, epaulements for cavalry, and bog-houses.

The number of gates to be made in lines depends on the number of troops destin'd for their defence, the design of the general, and the nature of the adjacent ground.

There were but few gates in the lines of *Philipsburg* in 1734, and they were no larger than those in the places of arms of a covert-way. The reason of this was I suppose, that our cavalry being sent back for want of subsistence, to the other side the *Rhine*, weakened us greatly ; and that we had a numerous army before us, that the taking of the place was our sole object, as it was so immediately necessary, to prevent the overflowing of the water, which would have deprived us of all communication from one side to the other.

We may also use them for those lines, which are only accessible by few roads, or for those, before which there is not ground enough to draw up ; but these different cases are exceptions to this rule.

We cannot in general have too many passages, as they are necessary in advancing or retreating ; they are, as in chap 5, the only means of abridging the time lost in filing off, and consequently of removing the defect *M. de Feuquier's* has so justly remarked.

Another



Another motive, no less important, should determine us to this; tho' the enemy, masters of the parapet, leap over in some places, while the body of men at a distance advance to charge them, a sally of some choice troops, made briskly from right and left, and at a small distance from the part attacked, is, as *M. de Santa Cruz*, and *de Folard* remark, one of the best motions that can be made; but to do this the barriers must not be too far distant from each other. *M. Vauban* in his treatise of the attac of places, allows 22 feet for the width of these gates; he prefers the placing them in the high roads or in the middle of the curtains, or near it, and covers them as we shall shew hereafter,

What he allows for lines of circumvallation, is equally proper for those we are speaking of; the passage is thus wide enough for the cavalry to file off by fours, and the infantry by eight: certainly a beaten road is preferable to a new one, and the passage cannot be better placed, than in the part the best flanked.

II. One point this illustrious engineer insists on, is that of a communication; there are few places that are not situated on rivers small or large, which consequently cuts the besiegers lines into two. The kind of camps we are speaking of, are not so frequent in this case, but it may happen; and besides, we commonly find rivulets, ditches, fenny grounds hollow ways and thickets.

Every

Every thing that may hinder, or retard the assistance, that one part should give another, is so essential an inconvenience, that in the words of that author \*, the safety of an army may depend on it; we cannot therefore be too attentive to this point.

If the right is separated from the left by a river †, he would have three or four bridges constructed, each 4 or 5 fathoms broad, and 50 or 60 fathoms distant from each other, to avoid confusion, and their extremities defended and covered by redans.

This I believe can be best done by boats, in regard to their length; but if the bridges be on trusses, which he prefers, as being more firm, and less liable to disorder, I don't know if, according to *Folard*, it would not be better, that they were broad enough to pass over by divisions at least; for, says he, "it does not require more time or trouble to make one passage, or a bridge of 100, or 120 feet broad, than several of 13, or 15." This is undeniable, and it is certain that more can pass over one bridge of 120 feet broad at once, than over four of 30; as these narrow bridges often oblige the column to halt, while the head passes over: in short, the more there are together, the stronger and in better state they are to charge, after their passage.

Which ever method we take, if the camp is cut by rivulets, ditches or hollow ways,

\* *Memoire pour la conduite des sieges.* *Vauban.*

† *Traité de l'attaque des places.* *Ibid.*

we practice the same as for rivers, where we make the slopes broad and gentle enough for cannon and cavalry to pass easily : if any part is marshy, causeways are formed, of the same breadth as the bridges.

The bushes, brambles and thickets, which may be found near the intrenchment at the rear of the camp, must be cut down close, that the horses may not stumble over the stumps ; finally omitting nothing in so important an article, multiplying the bridges, and other means, in proportion as we can spare time and workmen.

III. Platforms for cannon are made at the same time with the line ; they are commonly in the most salient parts, that is to say, in the flanked angles, where there is always more earth than necessary ; by this position their fires cross the better, and reach the farther.

These platforms are raised to 2 feet below the crown of the parapet ; if the excavation of the rounding of the ditch does not furnish earth enough to make them so large as needful, and to form the ramps, or slopes, the officer of the artillery, whom this more particularly regards, finishes them with his own men.

IV. The author I just now quoted, mentions epaulements to cover cavalry, as a precaution that has been neglected these 50 or 60 years past ; he does not say why the practice ceased, but perhaps it was because of the short duration of most sieges ; whatever was the



the reason, as he proposes them in counter-vallations, I may be permitted to give my opinion.

When we attac lines in broad day, we commonly cannonade them for many hours, before we attempt to force them; then in whatever manner the infantry is disposed, the parapet must be very low, and very bad, if it does not cover them and the cavalry, (that is, the body which should engage the last, and behind which the others should rally in case of need,) remains unnecessarily exposed to all the violence of this fire.

This exposition, which I take to be a just one, discovers my sentiments on this subject; it is true we do not now practise these epaulements, but is that a reason we ought not?

Tho' their utility appears evident to me, I do not pretend to say, they must be raised on all occasions; for example, when we intrench in haste, in the presence of an enemy, we must not do by halves what is absolutely necessary, and lose time, in what may only be useful by chance: besides, will it not be the heighth of imprudence to fatigue the men too much, who must engage a few hours after? so far from that, I would have these epaulements made only in those lines, constructed at leisure, which may be of use so long as the war lasts.

There is also some essential circumstances to be observed in placing these works.

" We raise them, says *Vauban*, principally in

"the parts commanded from without, seldom in any others." It is certain, that they are most wanted there, but they will yet be very useful in level ground, especially if the intrenchment be weak; but if the parapet of the line, by its profil or position, will cover the cavalry, or if the ground on which they are drawn up is so low, that they cannot be seen over the parapet, then such a precaution might be ridiculed, as the line itself serves instead of it, tho' always less perfect, because the troops, at a distance from the parapet, are most exposed to the enemy's shot.

These epaulements, generally made in the most open places, have one more advantage (supposing cavalry in proportion) which is that of covering the front, and sometimes the rear of the camp.

I never saw them but at the lines of the *Loutre*, between *Wissembourg* and *Alstatt*, but they were half in ruins: M. *Vauban* placed them at an equal distance from the line and the head of the camp, parallel to them: he made them about 40 fathoms long, 9 or 10 feet thick, and as high; and 50 or 60 fathoms interval between each.

V. It is common with the more northern nations, to place platoons of infantry between the squadrons: this precaution, which was so well known to *comte de Montecuculli*, and so much recommended by the commentator of *Polybius*, has often succeeded with  
the

the *Swedes* against the *Germans*, and with the *Germans* against the *Turks*. Such a fire, always very brisk, and better directed than that of carabines, is in effect very proper to protect the motions of the cavalry; may it not then be here as advantageous, at least in certain cases?

The cavalry of the line being repulsed and half broke, I would have them rally behind these epaulements; and to give them time and means to do it, there should be a sudden and smart fire, that they may not be followed too close.

A scheme I proposed in 1735, for raising a battery at *Philipsburg* to defend our forage, appears to me perfectly convenient here. P. XXXII.

We may form the common epaulement, only <sup>Fig. 2.</sup> observing to make a banquet in its ditch, and to raise its counterscarp like a flat parapet, about two feet high, that the fire may be the better directed.

It is obvious this will not occasion any increase of labour; and I believe that an epaulement thus lined, with 50 or 100 soldiers, firing nearly level with the ground, would be very terrible, and prove a great support to a disordered troop. This construction has yet this advantage, that if circumstances do not permit it to be used, there is no inconvenience follows.

In places level, but of small extent in proportion to the number of infantry to be disposed of, a Banquet may also be made behind



P. XXXII  
Fig. 3. the epaulement, and the usual slope given to the parapet: two lines of fire thus disposed, must probably have a great effect, as the depth of the ditch, and the slope of the upper banquet equally protects the soldiers above and below from the approach of the enemy's cavalry.

The crotchets, as in the plan, also seem good to cover them from oblique fires; they form little flanks from one epaulement to another, and even cover each other if the enemy come on the flanks; and in this case also, the two ends of the ditch, formed like the rest of the parapet, will greatly strengthen this defence.

VI. I shall only mention the inconveniencies of bog-houses; wherever they are placed in the lines, they are always troublesome; if without, they facilitate desertion; if within, they are a nuisance, and sometimes break the line of battle.

VII. If we do not take care to cover the gates, it is plain, that the enemy's cannon will break the barriers, and firing through, will batter one part of the camp, in proportion to its situation and the breadth of the openings.

XXXIII.  
Fig. 1. The custom in common lines is to cover them with detached redans in form of ravelins. M. *Vauban* makes the capital 22 fathoms, and the faces 28: the gorge is thus 34 fathoms, 3 feet, 10 inches; which, not agreeing with the sides of the figure in the book,

# FIELD

the emplacement, and the usual slope given to the parapet: two lines of fire thus disposed must probably have a great effect, as the depth of the ditch, and the slope of the parapet bander equally protect the soldiers above and below from the approach of the enemy's cavalry.

The crenels, as in the plan, also form little flanks from one emplacement to another, and even cover each other if the enemy come on the flanks: and in this case, the two ends of the ditch, joined like the rest of the parapet, will greatly strengthen this defence.

VI. In the section the inconvenience of dog-holes, wherever they are placed in the line, they are always troublesome; if without, they facilitate detection; if within, they are a nuisance; and sometimes break the line of battle.

VII. If we do not take care to cover the line, it is exposed to the enemy's cannon will break the barriers, and firing through will batter one part of the camp, in proportion to its situation and the breadth of the opening.

The uniform in common lines is to cover them with detached redans in form of saw lines. M. Vanden makes the capital as follows, and the faces 28; the gorge is 34 fathoms, 3 feet, 10 inches; which, agreeing with the sides of the figure in the book.

## INCLOSURES

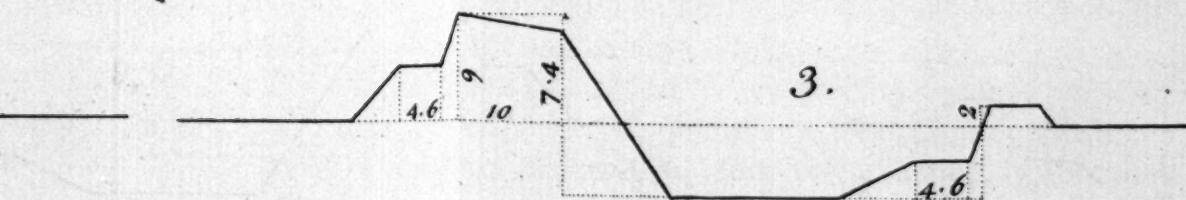


2.



ES and EPAULEMENTS.

Pl32. p. 229.





# ENGINEER

book, proves there is some mistake in the numbers

He forms the flanks by taking 10 fathoms from the face, and 5 from the gorge, but making thus an angle of  $98^{\circ} 35' 30''$  only with the counter-scarp, all the fire is directed towards the next redan, which gives room to suppose, that the principal design of these flanks, which in themselves is (by shortening the faces) to give more effect to the fire of the curtain, of which they yet make near 2 fathoms.

The ditch of these works, parallel to the faces, must be produced to that of the line, that it may be commanded throughout: by this we are obliged to raise and remove a great quantity of superfluous earth, and which must be esteemed an inconvenience, but much less than the other.

Besides, these ravellins produce a very good effect: the fire of their faces, crosses near the capital of the redans, which, as we have observed, have great need of this assistance; and it perfectly covers the gate and the bridge. An advantage very desirable in the ravellins of places, which often are abandoned for want of a true communication.

I see nothing more to be observed on this head, except that supposing the counter-scarp 3 fathoms from the parapet, as one of the lines of fire of the redan will pass at least six fathoms from the point of the ravellin, we cannot diminish the front of the line more than

book, proves there is some mistake in the numbers

He forms the flanks by taking 10 fathoms from the face, and 5 from the gorge, but making thus an angle of  $98^{\circ}$ ,  $35'$ ,  $30''$  only with the counterscarp, all the fire is directed towards the next redan, which gives room to suppose, that the principal design of these flanks, useless in themselves, is (by shortening the faces) to give more effect to the fire of the curtain, of which they yet mask near 25 fathoms.

The ditch of these works, parallel to the faces, must be produced to that of the line, that it may be commanded throughout: by this we are obliged to raise and remove a great quantity of superfluous earth, and which must be esteemed an inconvenience, but much less than the other.

Besides, these ravelins produce a very good effect: the fire of their faces, crosses near the capital of the redans, which, as we have observed, have great need of this assistance; and it perfectly covers the gate and the bridge. An advantage very desirable in the ravelins of places, which often are abandoned for want of a sure communication.

I see nothing more to be observed on this head, except, that supposing the counterscarp 3 fathoms from the parapet, as one of the lines of fire of the redan will pass at least six fathoms from the point of the ravelin, we cannot diminish the front of the line more

than 15 or 16 fathoms; for if, for example, it was reduced to 100 fathoms, this point would be battered.

XXXIII.  
Fig. 2.

VIII. A few words added to the inspection of the plans, will shew my method of covering the gates of the different kinds of lines proposed. For those with redans, where the barriers cannot be better placed than in the salient of the curtain, mask them with a lunette of 16 fathoms capital, reckoning from angle to angle: make the faces 20 fathoms long, drawing them to the reentrant of the redans, and the fire, supposed perpendicular, will graze without battering them; I here mean the second scheme of 150 fathoms front, which on that account is preferable to the other. The extremities of the ditch of this little work, if not full of water, must be sloped in a glacis reversed, that the enemy may not find any shelter.

XXXIII.  
Fig. 3.

A lunette of 20 fathoms capital, and 15 fathoms demi-gorge, placed at the reentrant of lines, with tenailles, will cover their barrier.

XXXIII.  
Fig. 4.

That of indented lines, are masked by a reduit, formed on one side by the prolongation of the branch, and the other parallel to the crotchet.

Pl. XX.  
Fig. 3, 4.

The excavation of the branches of the communication, viz. the part of the branches between the traverse and the ditch, serve for covering the barrier of the two kinds of lines with lunettes, and thus save so much work.

The



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salient of the curtain, mark them with a line

nette of 10 fathoms capital, reckoning from

angle to angle; make the faces 20 fathoms

long, drawing the line to the rear of the

redans, and the fire, supposed perpendicular,

will graze without battering them; I here

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may not find any shelter.

A line of 20 fathoms capital, and 15

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of lines, with redans, will cover their bar-

rier.

XIII. That of indented lines, are marked by a

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the crotchet.

The excavation of the branches of the

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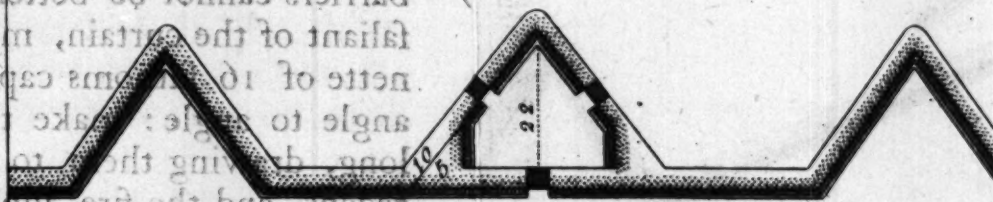
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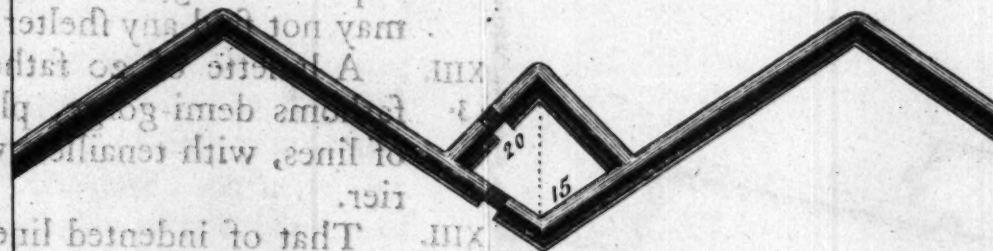
# GATES



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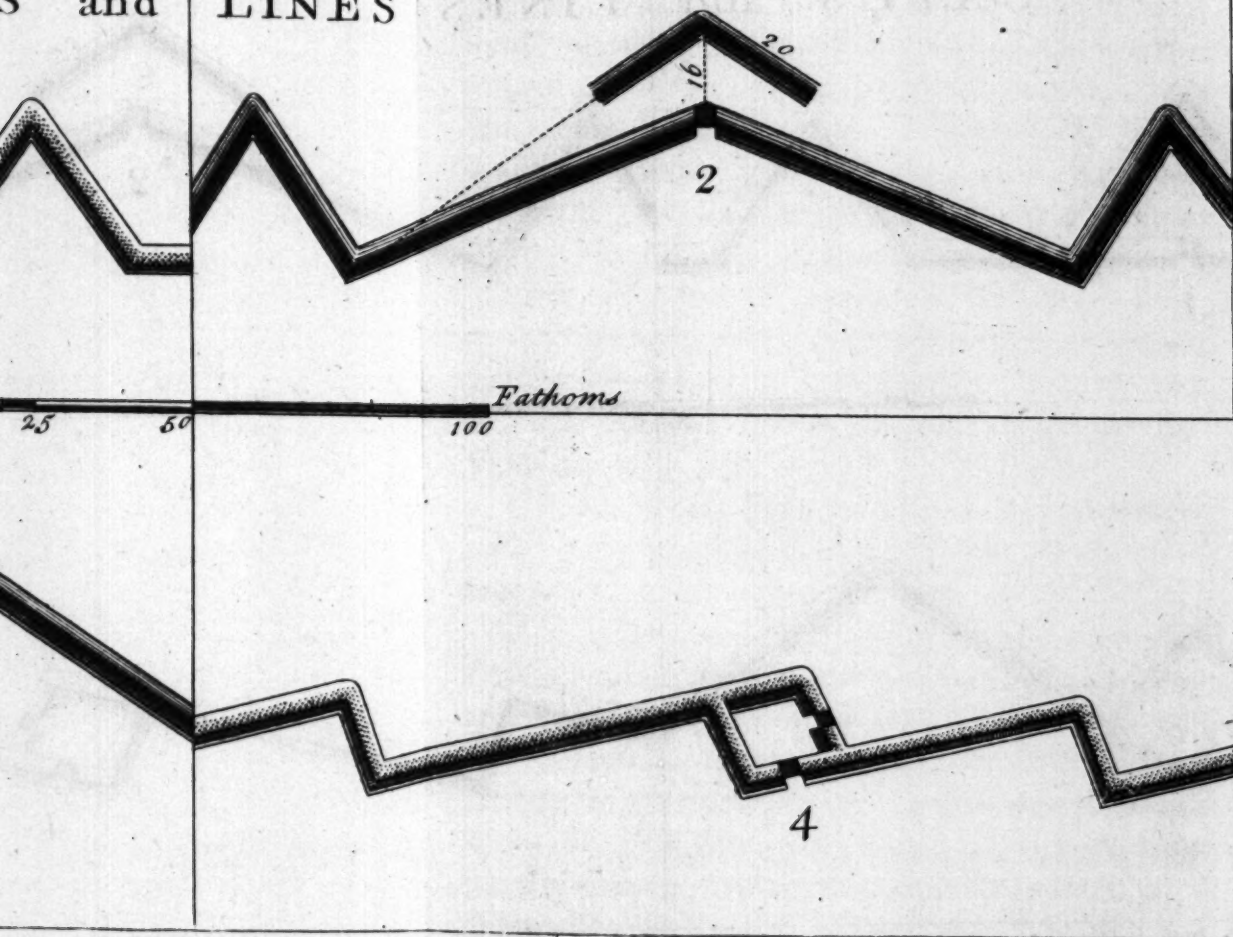
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3

S and LINES

Pl. 33. p. 230.



## ENGINEER.

The bastion lines in this respect are much more difficult than the rest, and unfortunately I cannot quote those of Philippsburg, for their barriers were not covered. The difficulty arises, by supposing, as I have done throughout, the small arms to fire at right angles; trawling cannot well be used, for if they are only separated from the faces of the bastion, by the breadth of the ditch, they mark almost all the fire of the flanks, as already observed; and if they are as far from the faces, as should be, that is, the length of the flanks, we not only run the risk of having their pieces flanked, and taken in rear, by the gorge, but the communication would not be so secure, and the barrier would even be seen obliquely from the extremities of the

shoulder.

I have given here two ways of avoiding these inconveniences, the reader may decide which seems to merit the preference.

The first, to make a sawtooth before the curtain: it is 12 fathoms broad from the parapet that carries it, may pass easily, and that they may be flanked by the bastion. The second is a little more compounded; draw a line from the shoulder of one bastion to that of the next; divide this line into two, and from the middle let fall a perpendicular inwards, equal to half this line, its extremity will be the point of the angle of a redan reversed, whose branches are drawn from that point to the shoulders of the bastion. The curtain



The bastion lines in this respect are much more difficult than the rest, and unfortunately I cannot quote those of *Philipsburg*, for their barriers were not covered. The difficulty arises, by supposing, as I have done throughout, the small arms to fire at right angles; ravelins cannot well be used, for if they are only separated from the faces of the bastion, by the breadth of the ditch, they mask almost all the fire of the flanks, as already observed; and if they are as far from the faces, as should be, that is, the length of the flanks, we not only run the risk of having these pieces flanked, and taken in rear, by the gorge, but the communication would not be so secure, and the barrier wou'd even be seen obliquely from the extremities of the shoulder.

I have given here two ways of avoiding these inconveniencies, the reader may decide which seems to merit the preference.

The first is, to make a *Fausbraye* before the curtain: it is 12 fathoms broad from the parapet that carriages may pass easily, and that they may be flanked by the bastion. The second is a little more compounded; draw a line from the shoulder of one bastion to that of the next; divide this line into two, and from the middle let fall a perpendicular inwards, equal to half this line, its extremity will be the point of the angle of a redan reversed, whose branches are drawn from that point to the shoulders of the bastion. The curtain

curtain being thus broken a second time, raise a parapet on the first tracing, and it will shew the figure.

This reentrant angle being a right one, and its branches grazing the shoulders, their fire, tho' less advanced than they were, pass beyond the capitals of the bastions, and cut them, which must be an advantage. Detached bastions are very necessary to cover gates, and the lines with detached works, or those detached in parts, having no occasion for these additional works, I have nothing more to add to this article.

IX. In my maxims, I said we might, without danger, even in dry ground, cover every flanked work with an advanced ditch, provided the flanks were not too oblique, and sufficiently saliant; I will here explain myself.

An advanced ditch will be always useful, and cease to be dangerous, when seen and battered throughout its extent; the enemy will then not find that shelter, that cover, and that security, which have made the greatest masters reject them; in short, the enemy will be as much exposed there, as on the counterscarp,

To effect this, 1<sup>st</sup>, the advanced ditch must be enfiladed at right angles, or at least under an angle from 90 to 100 degrees, with the flanks of the line: 2<sup>dly</sup>, consequently its distance from the ditch must be such, that its counterscarp does not project beyond the interior

terior angle of the shoulder, that the whole ditch may be under the fire of some part of the flank: 3<sup>dly</sup>, that at the rentrants the advanced ditch be produced, and cut down in form of a glacis reversed, so as to leave no cover, as I have already shewn.

These circumstances, which remove all difficulties, are easily to be observed, in the most part of the works I have proposed. I will give two examples. In lines with re-xxxiv. dans, trace the advanced ditch parallel to the Fig. 3. ditch, because the angle of the flank with the branch is only  $99^{\circ} 34'$ , which is not too much; and if I had made it square with the line, it would have thrown me more than 16 fathoms towards the country opposite to the break, and in proportion opposite to the point of the redan.

In broken lines with tenailles, which I xxxiv. here suppose with lunettes, I do not follow Fig. 4. the parapet, which lengthens the ditch to no purpose, and which would also be much less defended; but it is parallel to the principal lines of defence, and consequently squares upon the flanks. If to this we add the necessary slopes, it must be confessed that this piece of fortification, far from being hurtful, becomes useful even in dry ground.

Its most remarkable advantages are, 1<sup>st</sup>, that if the slope be the least steep, the first rank of the assailants, embarrassed with their fascines, throw them in here to leap over, so that they have them not to fill up the ditch

of  $\angle$



of the intrenchment. 2<sup>dly</sup>, that far from serving the enemy as a place of arms, to take breadth in, and there oppose the line with small arms, as they will find no cover there, they will quickly leap out of it, and consequently in disorder.

These obstacles become almost insurmountable, if we have time to dig pits between the ditches: nothing is fitter to disconcert an enemy in an attack, or more difficult to fill up. 'Tis with this view, viz that the enemy may not know where to tread, that in the first figure, and at the salient of the second, I have only left about four fathoms distance, from one ditch to another, that three rows of these pits placed alternately may be sufficient.

The earth of these wells is thrown up in little heaps in their intervals; that of the advanced ditch, whose contents is less considerable, may be thrown in form of a glacis on its counterescarp.

X. We may draw new advantages from advanced ditches, when judged necessary: viz. That of constructing ravelins before the curtains of bastion'd fronts, without falling into the inconveniences mentioned in the 8th article of this chapter.

It is evident, that thus we are free from the danger of being taken by the gorge, without being obliged to mask part of the fire of the flanks: this is an essential point, yet as there must be a gate in the line, to communicate

municate with this detached work, and we must as much as possible hide this gate from the enemy, there must be some other measures taken.

We shall fulfil this point only in proportion as we diminish the distance of the ditches: therefore we must particularly observe. That the fire of the flank only beginning from the interior angle of the shoulder, we may without danger from thence draw the demi-gorge of the ravelins, which will thus lessen its distance from the parapet: we do not in fact gain much by this, but we should much more, if we placed two pieces of cannon in that part of the flank next the shoulder, which if charged with grape, and pointed between the two ditches, at the time of the assault, must do great execution. Besides, as the distances is small, these pieces may be moved from the flanks to the faces, having but one to remove entirely.

We may then without inconvenience draw the demi-gorge of the ravelin, and the counterescarp of the advanced ditch, 5 fathoms from the angle of the shoulder, taken externally, so that drawing the faces of the ravelin on the faces, at the like distance from the angles, the barrier, and also the communication will be pretty well covered.

This ravelin is traced according to the common method, viz. taking the distance of the two points; where the faces of the ravelin fall upon the faces of the bastions, as a base,

XXXIV.  
Fig. 5.

base, and constructing two triangles thereon, one a rectangular, and the other an equilateral, and dividing the distance of their summits into two, that point will be the point of the salient angle of the ravelin.

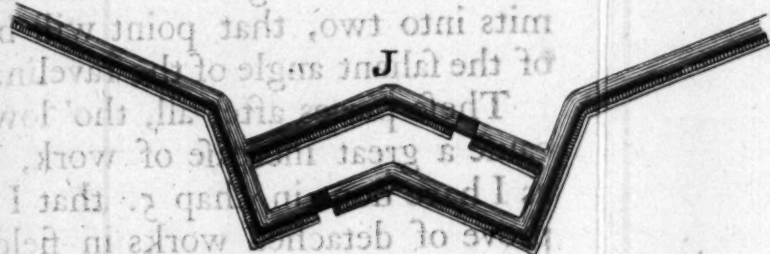
These pieces after all, tho' low and weak, cause a great increase of work, and I own, as I have done in chap 5. that I do not approve of detached works in field-fortifications, especially when we have not means and time to render them capable of resisting an assault. I therefore think we should only make ravelins to intrenchments of small extent, and made with great care; such, for example, as intrenched camps, especially when they can only be attacked in one part, as those of *Russenheim* and *Spire*.

#### OBSERVATIONS on the eleventh Chapter.

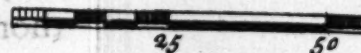
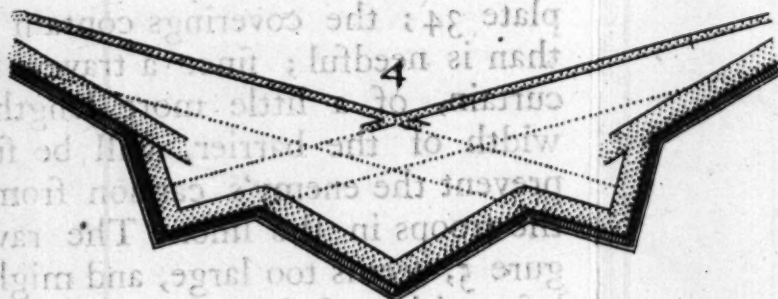
Little can be added to what the author says, concerning barriers and their coverings. We shall only observe, that in bastioned lines, as represented in fig. 1, 2, plate 34; the coverings contain more work than is needful; since a travers behind the curtain, of a little more length than the width of the barrier, will be sufficient to prevent the enemy's cannon from molesting the troops in the line. The ravelin in figure 5, seems too large, and might be much less, without losing the advantages the author proposes by its construction. For if the



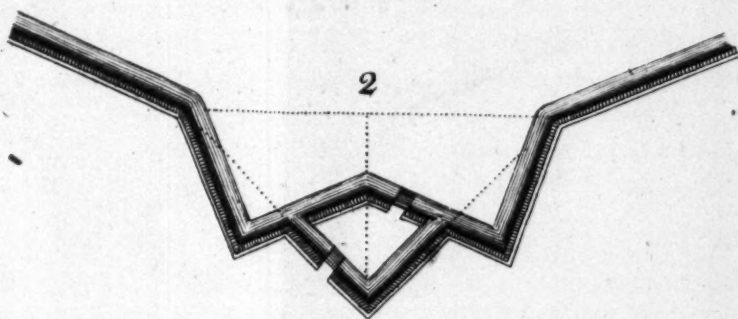
## GATES of LINES



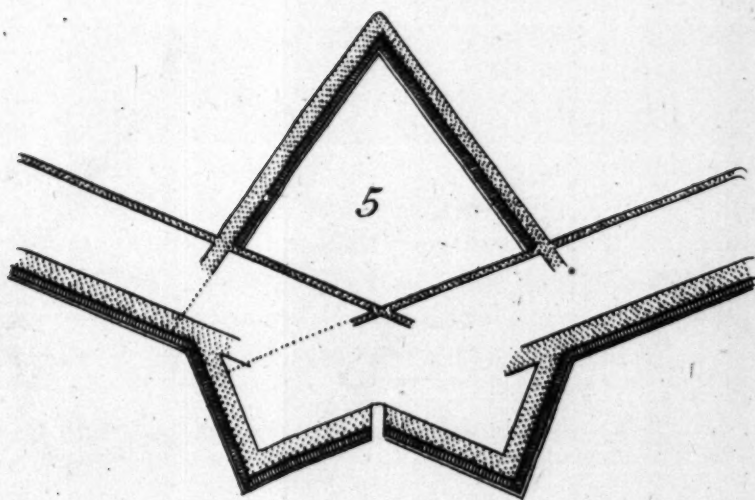
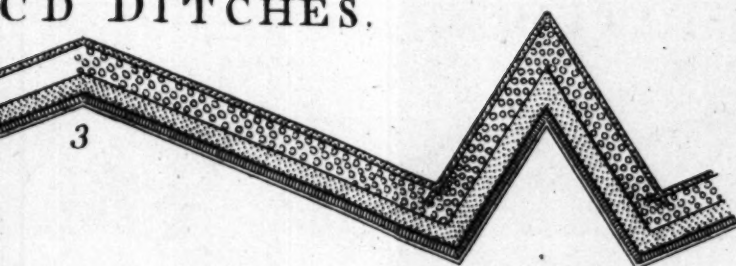
## ADVANC'D



INES and BASTIONS.



C'D DITCHES.



50 100 Fathoms

## ENGINEER.

the counter-top of the second ditch, which terminates the gorge of the ravelin, was to meet the inner angles of the shoulders, as likewise the faces of the ravelin, both being produced, it would be sufficient; and I would prefer the making the passages out of the ravelins, at the extremities of the faces, and not in the middle of them; because they would in that case be defended by the fire from the opposite flank directly, and by the opposite face in flank, which is all that can be done or desired; and the fire of the flanks would then not be masked by any part of the ravelin.



the counterscarp of the second ditch, which terminates the gorge of the ravelin, was to meet the inner angles of the shoulders, as likewise the faces of the ravelin, both being produced, it would be sufficient; and I would prefer the making the passages out of the ravelins, at the extremities of the faces, and not in the middle of them; because they would in that case be defended by the fire, from the opposite flank directly, and by the opposite face in flank, which is all that can be done or desired; and the fire of the flanks would then not be masked by any part of the ravelin.

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## CHAPTER THE TWELFTH.

I. *Irregular fortifications : maxims :* II. *Reentrant angles.* III. *Saliant angles.* IV. *Manner of occupying heights, of preventing their being enfiladed, and tracing works on their descent.* V. *Reflections on heights.* VI. *Villages and buildings within reach of the work.* VII. *Case where detached works are necessary or useful.* VIII. *Woods.* IX. *Morasses, hollows, hollow roads, hedges, rivulets.* X. *Manner of proportioning to the ground the lengths of the fronts of the proposed methods.*

I. **I** have hitherto supposed the intrenchments raised on level ground, and the lines so uniform, that all the tenailles were equally disposed, and on the same line : in a word, I have supposed the works quite regular. I thus followed the method taken in treating of the fortification of places, and I did it with the same intent, viz. to form the subject, by establishing general methods, to follow as much as possible in the execution ; for ground is seldom found so uniform, but that the regularity is at least as difficult to be observed in one case, as in the other.

We should then much less regard what has been said on this subject as positive precepts, than as general notions, proper to multiply and rectify the particular ideas, which circumstances require in practice. The engineer

gineer must know how to act, according to the circumstances, and it is a great advantage to him to have many different methods to compare, and to follow that which seems the best.

But we shall presently find how much we must expect from theory; for the irregularities of the ground and other circumstances, vary so much, that all that can be added to what has been already treated of, is to shew how to take certain advantages, and to avoid, and to surmount some foreseen difficulties, generally very common.

I shall give but few maxims on this subject; but they are as important as extensive: one, that all parts be as much as possible, so equally capable of resistance, that one part need not be feared more than another; its plain in this respect we must regard the advantages of the ground: the other, to have as much attention, to gain by every thing that may be favourable, as to avoid what may be hurtful.

II. A turning, a winding, a projection in the lines may be regarded as an irregularity, but that is almost always unavoidable. If the angle it forms be a reentrant, it sometimes encreases the defence; if a salient, the contrary. Rentring angles, right or obtuse, and those which are acute are often fortified after different methods. A retring from 90 to 120 degrees, though the defence be very oblique, forms a tenaille, and consequently flanks itself, R

P. XXXV.

Fig. 1, 2,

3, 4.



itself, provided its branches, being of a proper length, are shortened by degrees, as it is more open; so that at 90 degrees they have but 80 fathoms; at 100 degrees 70 fathoms; and 110 degrees 60 fathoms, and at 120 degrees they have but 50 fathoms.

This shortening is necessary, that one part of the fires may cross the capitals, which could not be without that; for they fly off from the saliants, in proportion as the angle is obtuse. I do not give this as a geometrical rule, it will only serve in practice, and sufficient in common cases. I say in common cases, for if the ground on the right and left is not on the same line, we must have regard to the difference the inclination of these new angles gives to the capital. The figure will explain what I mean, and shew that the saliant on one side, tho' double in length to the other, can be better defended.

P.XXXV.  
Fig. 5.

When the branches are too long, or the angle very open, some indented work will remedy all at once, as it not only forms new flanks, but also diminish the opening.

P.XXXV.  
Fig. 6.

As to reentrants under 90 degrees, they are fortified according to the breadth of their opening: if it is only 120 fathoms, it will do well enough, as an enemy would be thereby engaged between two fires. A simple parapet in a right line, always necessary to cover the communication, and to prevent the camp from being battered obliquely, seems sufficient; yet as the enemy may throw themselves  
all

all on one side, or attac both at once, it is best, that the anterior parts be flanked, and the branches so disposed, at least for a certain depth, that they may be used without firing on each other.

On this occasion I shall once more venture<sup>P.XXXV</sup> my thoughts, in giving a scheme for an opening of about 200 fathoms: I know that in the treatise of the attac of places we find one of these rentrants fortified to the very bottom by indented works; but if we reflect that branches with more than 200 fathoms interval, exceed the range of a musket, it must be allowed as this is a different case, I cannot follow this example without breaking through the rules.

III. *Vauban*, as well in this, as in his instruction on the siege of *Aeth*, gives some salient angles, all fortified; the most open by bastions, the others of 90 degrees at least by demi-bastions, and by the intrenched camp at *Dunkirk* it appears, that when they were acute he cut them to make tenailles.

We are seldom obliged to make these last angles; yet as we may have occasion to possess a point of land, I will shew in a general manner how I would flank all from 60 degrees to the greatest opening.

The angle of 60 degrees, being the most<sup>P.XXXV</sup> acute that can be admitted in fortification,<sup>Fig. 8.</sup> must not be diminished: its flanks must consequently be taken externally; the best for this purpose, as being the least salient, are

indented crotchets, which may serve for all others.

P.XXXV. As the right angle has 30 degrees more, it may be defended different ways; I would prefer the preceding, taking the crotchet within, if possible, for it will be yet 61 deg. 56 min. If a demi-bastion is thought best, care must be taken that the face be defended, and that no part in the front fires on another; but independant of the irregularity, it appears to me that we shall have gained nothing, for it is the saliant that must be defended, and two flanks near 15 fathoms each, one of which is only 60 fathoms distant, is better than one which is less than 27, and more than double that distance, which is that of the common redans.

P.XXXV. If these considerations do not appear solid enough, trace that figure in this manner. Fig. 10. Draw a parallel 22 fathoms from one of the sides; at 120 fathoms from the angle, raise a redan of 22 fathoms perpendicular, and 15 fathoms demi-gorge; draw one line of defence from the angle of the figure to the reentrant of the redan, and the other from the point of the redan to the gorge of the demi-bastion, which make 25 fathoms; elevate the flank perpendicular to this last line.

This angle being square, might be made a bastion; but so crowded, and of so little defence, that we should reject such a construction here, as much as in the fortification of places,



places, where it is never used, when it can be avoided.

The angle of 120 degrees, being that of an<sup>P.XXXV.</sup> exagon, may be fortified according to all<sup>Fig. 11.</sup> the methods I have given, except in those with tenailles, and broken tenailles; it wants but 30 min. of being enough for this; so that it may be used, diminishing the perpendicular two or three feet only, for greater exactness.

Finally, the angle of 150 deg. is open e-<sup>P.XXXV.</sup> enough to execute any of the different schemes<sup>Fig. 12.</sup> that may be chosen for the rest of the lines.

Whatever then be the saliant, we can flank it according to one or more of the methods I have given for regular fortification, and it is certainly an advantage to confine these irregularities to fixed rules, observing only, that if the angle be less than 60 deg. or that we cannot use the crotchets, we must make it less saliant to give it the greater opening.

IV. The unequal heights of the ground, is one of the principal causes of the irregularities, as well in the profils, as in the plan of the works.

The saliants of every kind of fortification must be at least as high as their branches, even supposing the ground perfectly level; for if the part the most advanced should be lowest, its parapet would cover it less in proportion as one would be farther from it, whereas if the saliant be highest, one cannot

be seen even from a much higher ground than that we are on.

It is therefore always useful, and often absolutely necessary to raise the flanked angles higher than the rest: the earth taken from the rounding of the ditch serves for this purpose; but as this is of little consequence, excepting in even ground, we must endeavour to place these angles on the highest places; we also thus prevent the bad effects of the ricochet, and command better in front.

When we cannot by this means prevent being seen from an eminence too near, and have not time to raise the parapet of the angle as high as needful, there are two methods left, little or not at all used in *France*. The one is to raise the parapet of the angle some feet, in form of a cavalier, for the breadth of the terreplein, that the troops which occupy the branches may be covered. This the *Germans* call bonnets, and we surlouts; there were some in the hornworks at *Philipsburg*.

If it is only some particular work we would cover, the same method is used by turning one or more angles to the enemy: these surlouts are also so proper to guard against the ricochet, that I am surprised they are not more used in our fortified places.

The other expedient signifies little against cannon, but it is readily and easily done, and entirely covers the men; it is to place, on the parapet that should be raised, a row of gabions

gabions larger at top than at bottom, that they may form a kind of loop-holes; M. de Caligni, director of fortifications, from whom I had this idea, assured me he had used it with success. These gabions resemble much those hampers or baskets on the rampart, which, according to the chevalier de Ville, and some other authors, were formerly used instead of our sand-bags, if their chief use was not to prevent being plunged; a more essential one than that for which baskets was invented. In short, if these means will not do, we must, according to Vauban, possess the commanding ground, either by extending the lines to it, or by good redouts, or some other works.

When the line of the front cuts one of these eminences, and that we must consequently mount it, and descend it, was it even parallel to the enemy, we are obliged to break it, in such manner that the salient be at top, and the reentrant at bottom. The reason of this, little different from what we have already alledged, is, that if the line was continued strait on, we should in reality be covered in front, but not being so on the side where the ground falls, the parapet of that part would not hinder our being seen obliquely.

It is seldom we project beyond the line, in descending a hill, yet it may happen, as in the communication of some detached work; the only method I know to avoid be-



being plunged, is to trace the communication in zig-zags, like the branches of a trench; the more acute the angles are, the less they are subject to be enfiladed, and the shorter the branches are, the more they are covered by the crotchets.

V. I will add some reflections on so important a subject. We should, if possible, possess the heights, was it only to prevent the enemy from molesting us from them; yet they are not absolutely so advantageous in themselves, as is commonly imagined.

All these, in proportion to their height, discover at a distance, and command the depth of the battalions and columns of the assailants. All have besides the advantage of being secured from the ricochet, and even of diminishing the effect of cannon, which, firing from a low place to a higher, with much difficulty enters the parapet, which it batters obliquely in respect to its thickness.

We should also add, that the first rank of the enemy being higher than the second in ascending, it is consequently the only one that can fire on the intrenchment. These advantages are real, but the inconveniences attending them are more so.

It is essential here to distinguish two different sorts of fire; the rasant or grazing, in this respect, is that which going in a direction parallel to the horizon, beats down all it meets with within its range, and the siccant or plunging, that which fires from a higher

higher on a lower place, and only damages whatever it meets with near the point where it falls.

This distinction being understood, explains one part of what I would say. Whatever be the height, every shot that falls, and does not rise again, will be fichant or plunging, and consequently less dangerous, even supposing the soldier to take aim; and as it is almost impossible, let the elevation be ever so little to raise himself enough, it is evident that cannon will have little effect, and small arms still less, and this inconveniency increases in proportion as the enemy approaches.

This concerns the plain, that is to say, what is beyond the foot of the hill; as to ramps or slopes I shall here suppose them of two different sorts.

When they are so steep that the enemy cannot easily ascend, and we can leap from the intrenchment, doubtless we shall repulse an enemy out of breadth, and probably in disorder, with much ease; especially if, by imprudence, or too much heat, they are led on too fast; but here also we cannot fire on the slope without being greatly exposed, or even without mounting on the parapet.

If the slope be gentle or easy, we are less exposed, but the enemy will march with as good order, and almost with as much ease, as on a level, so that we do not gain much by it; for I am not of M. *de Folard's* opinion, that infantry charging from a higher

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on a lower place, come with greater weight, and the cavalry the contrary.

I believe we may conclude, that the most advantageous heights, in all respects are those which are steep and difficult of access, provided they are so situated, that flanks may be made to batter what we cannot see in front; or else those eminences with a gentle and easy slope, when this natural glacis is near the length of a musket range.

We cannot be too attentive in placing these works, so that they possess the summit of the hill; at least we must take care, that by the irregularity of the ground some part of the camp, or the troops when drawn up, be not seen from without.

VI. When a village is found within reach of the shot, it must either be left in rear, or fortified so as to serve as a flank to the rest.

This is of great importance, for if you abandon it to the enemy, it serves them as a support, it hides their dispositions and motions, and enables them to discover yours.

When the village is so near as to be hurtful, and in a low ground, or too much embarrassed with hedges, &c. to run the line there, there is not much more to be done than making it a detached post: so long as this post shall subsist, it will be a security to that part that cannot be attacked, but by exposing their flank to the fire of the village: but as it is liable to be attacked, because it is detached, it will be prudent, let the distance



tance be ever so little, to secure a communication, so as to prevent its being easily surrounded.

Some redouts are sufficient for this; every difficulty would then be overcome, if there did not often remain inconveniences much more considerable: we have seen in chap. 4. that there are many villages that cannot be fortified; besides, such a place requires much work, and to guard it requires more troops than we are sometimes able to detach from an army.

In these circumstances, the common expedient, and which appears the best, is to burn the village; but I venture to affirm from what I have often seen, and lately at the sieges in *Flanders*, that unless the houses are all of wood, as in *Bobemia* and the *upper Palatinate*, we gain little or nothing by it. What advantage do we reap by setting fire to a house built with earth or masonry? the roof, floors and doors consume, but the walls remain, and they are sufficient to cover the enemy. Besides, we shall find that it is not the houses, so much as trees, hedges, and the walls of enclosures, which affords this cover, and the fire does not destroy them.

We should not then have recourse to this means, but when we have time to cut down and level with the ground all that may be hurtful; as it is rare that we do this, but when it cannot be avoided, that is to say, at the

the last push, it is also very seldom we reap any advantage by these cruel actions.

The surest way is to avoid such a troublesome neighbourhood as much as possible. As to less considerable enclosed places, such as houses or castles, we should not hesitate to possess them, as little useful as they may be, for fear they might be hurtful, as they are supported with little work and few troops. We have shewn how to defend them in chap. 3.

VII. These last works are so necessary, that when not found ready made, we are obliged to construct others instead of them. One of the most essential maxims in every kind of fortification is, not to leave the enemy any cover, within a certain extent, which extent should never be less than that of musket range. If the line or intrenchment is at a distance from a valley, too low to be seen, or any other circumstances produces the like effect, there must of course be some work added.

The same should be done to secure communications to heights, when we fear they may be hurtful; in fine, if we have a dam, a bridge, a ford, or any other defile before us, it must be defended near and by a grazing fire. Besides these detached works, others are sometimes made, which are only separated from the line by the ditch: these are made to strengthen a place greatly exposed, to possess a point of land, or to flank the adjacent parts. I

I shall not give the various methods of tracing these works, as their figure depends on circumstances; and as I have given so many different schemes already, no one can be at a loss in this respect; I shall only add, that the most material thing is to secure the communications, and to turn the branches, so that they do not fire on the lines; the adjacent parts also must be so turned as not to fire on the branches.

VIII. Woods as well as heights have their advantages and defects; if full of thickets, and difficult to pass through, and not above 100 or 150 fathoms distant, they are advantageous to the defence of the intrenchment, as the enemy cannot make their way through, without being heard by the patrols, and advanced guards, which gives us an opportunity of drawing our troops to the places attacked; besides, they run the risk of being charged before they can get clear, and are drawn up: in this case the barriers should be large, and at a little distance from each other, so as to fall out with a considerable front, and at many places at once.

But if the wood be clear, high, and without brambles and briars, as most fir woods are, and are cut through by broad and good roads, as that of *Philipsburg*, the enemy will be able to conceal their dispositions and marches, to attack us when we least think of it, and to retreat when they please, without fear of being pursued, at least very speedily, provided



ded they have taken the precaution to line the borders with infantry, to favour their retreat.

If the wood is nearer, the enemy have greater advantages, and if at a greater distance, as 400 or 500 fathoms, they cannot indeed fall on the line, so very unexpectedly, but their retreat will not be less secure. In short, when we are masters to chuse the nature and situation of the ground, it is the business of the general, rather than of the engineer, to weigh well these considerations.

When the line must pass through a wood, and by nature it is not capable of supplying the place of one, for reasons given in chap. 2. cut it down to the ground, from the foot of the intrenchment to the rear of the camp, and pile up the fellings at 150 fathoms in front at least.

IX. A morass, a hollow, a hollow way, a quick-hedge, even the smallest brooks, become objects to be regarded, either to draw some advantages from them, or to prevent their being hurtful.

A morass of any kind is always an advantage, if it extends to the foot of the line, since it renders it inaccessible to cavalry at least: if it be of any breadth, and its bottom boggy, it serves as an intrenchment; if it appears needful to line it with a parapet, it need only be an epaulement against cannon, consequently need not be flanked; but we cannot reconnoitre and sound these morasses too well,

well, that we may know how far we may depend on them; there are thousands of examples, and I have seen droves of oxen crossing those with little trouble, which were thought in the army, to be impracticable, and which perhaps were so some months before.

Hollows, hollow roads, and in general, every thing that may serve as a cover, must either be enfiladed or flanked by the line itself, or as in chap. 7. by some detached work, so as to discover the bottom. These cavities not only cease to be hurtful, but also become useful, as they are so many additional obstacles to the enemy: if we find a quick-hedge, and the intrenchment can be so turned, as to preserve it on its berm, it will serve instead of pallisades.

If there is a brook too small for an inundation, it must be damm'd up here and there to fill it full to its banks, and form little pools: or, if it runs into the intrenchment, we must try to fill the ditch with it; I shall not here speak of considerable brooks, nor rivers, having already largely treated of them in chap. 9.

X. The different projections of the line, being always determined by some one of these circumstances, it is evident we cannot always make the fronts of an equal length, as we are often obliged to add or diminish a certain extent.

The numbers and variety of methods I have given, will be of great assistance in this respect,

respect, as they are for fronts of 60, 100, 120 and 150 fathoms, besides these fronts may be diminished, provided it is done with judgment.

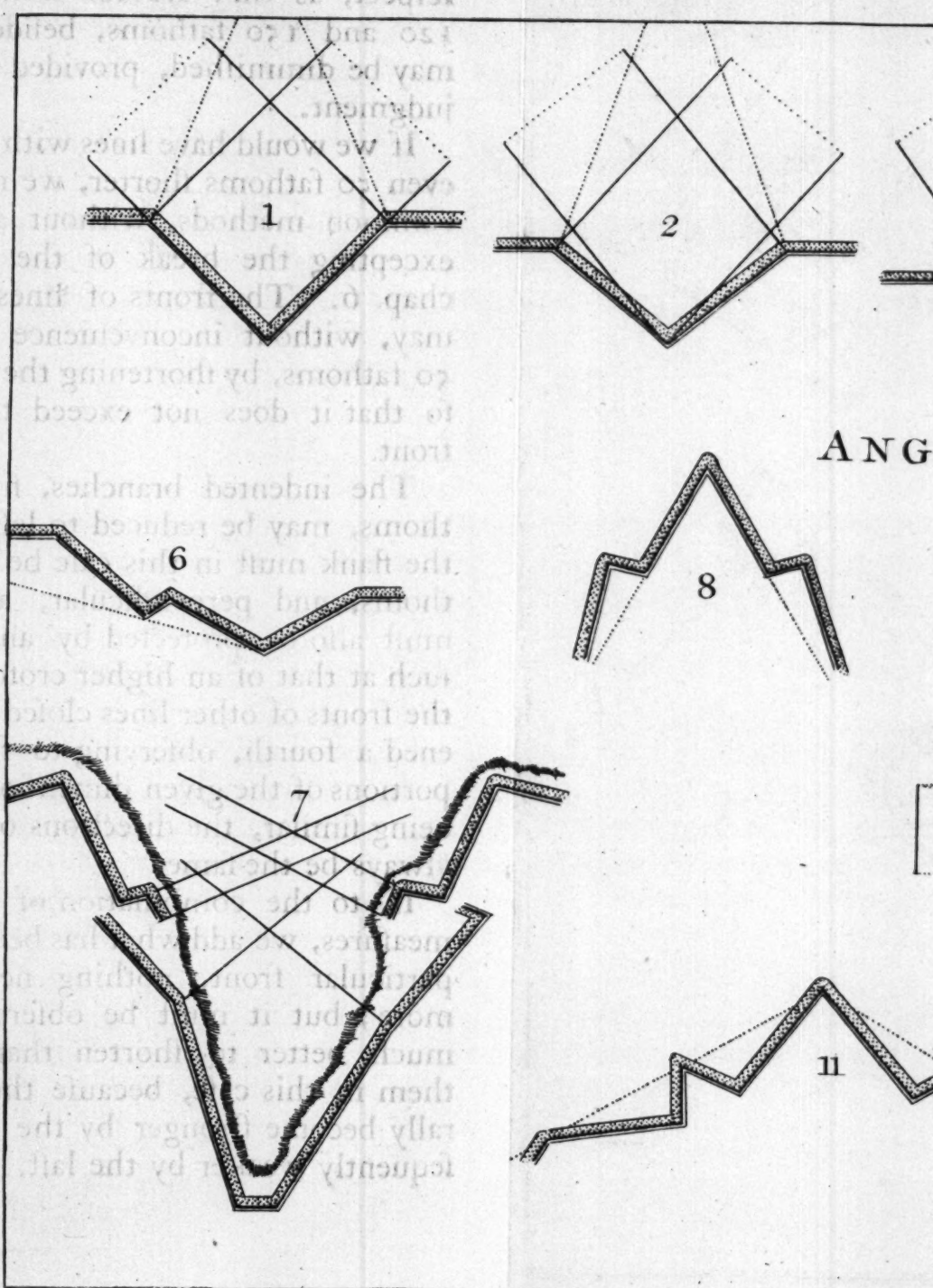
If we would have lines with redans, 30 and even 50 fathoms shorter, we may follow the common methods, without any alteration, excepting the break of the curtain, as in chap. 6. The fronts of lines with tenailles may, without inconvenience be reduced to 50 fathoms, by shortening the perpendicular, so that it does not exceed the half of the front.

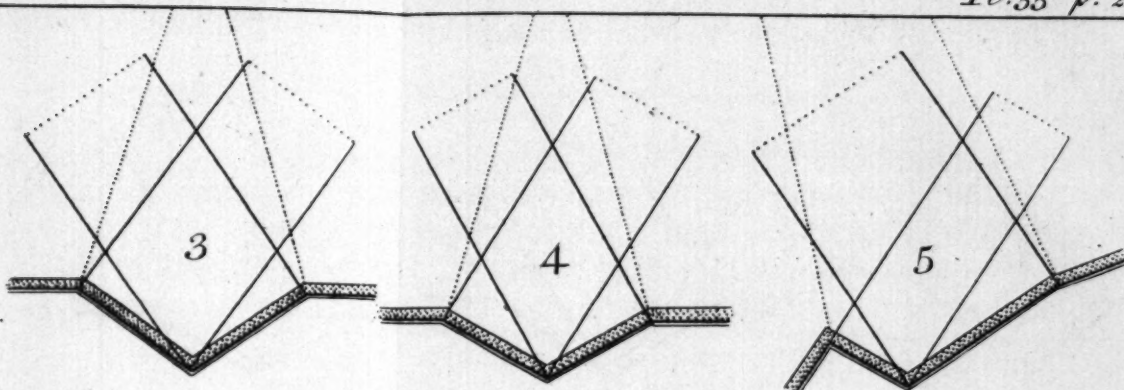
The indented branches, fixed at 60 fathoms, may be reduced to less than 30, but the flank must in this case be at least 12 fathoms, and perpendicular, and its branch must also be protected by an adjacent fire, such as that of an higher crotchet. Finally, the fronts of other lines closed may be shortened a fourth, observing to follow the proportions of the given dimensions; the figures being similar, the directions of the fires will always be the same.

If, to the combination of these different measures, we add what has been said on each particular front, nothing need be desired more; but it must be observed, that it is much better to shorten than to lengthen them in this case, because the fronts generally become stronger by the first, and consequently weaker by the last.

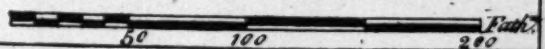
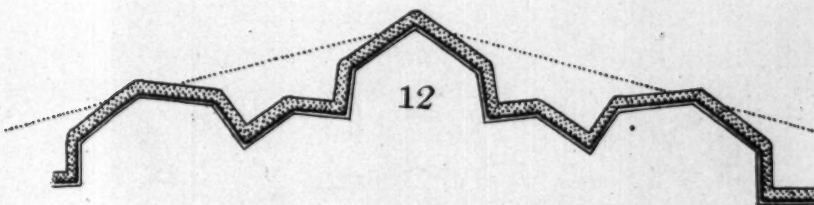
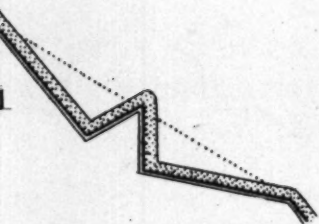
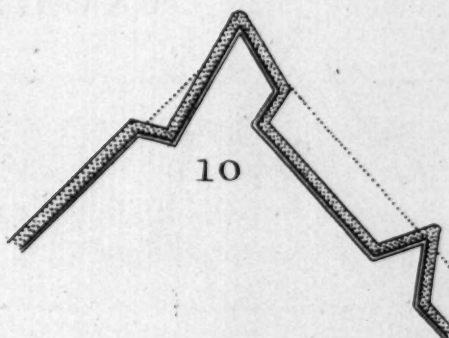
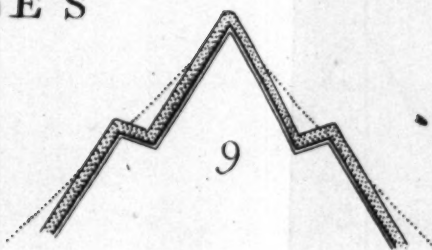


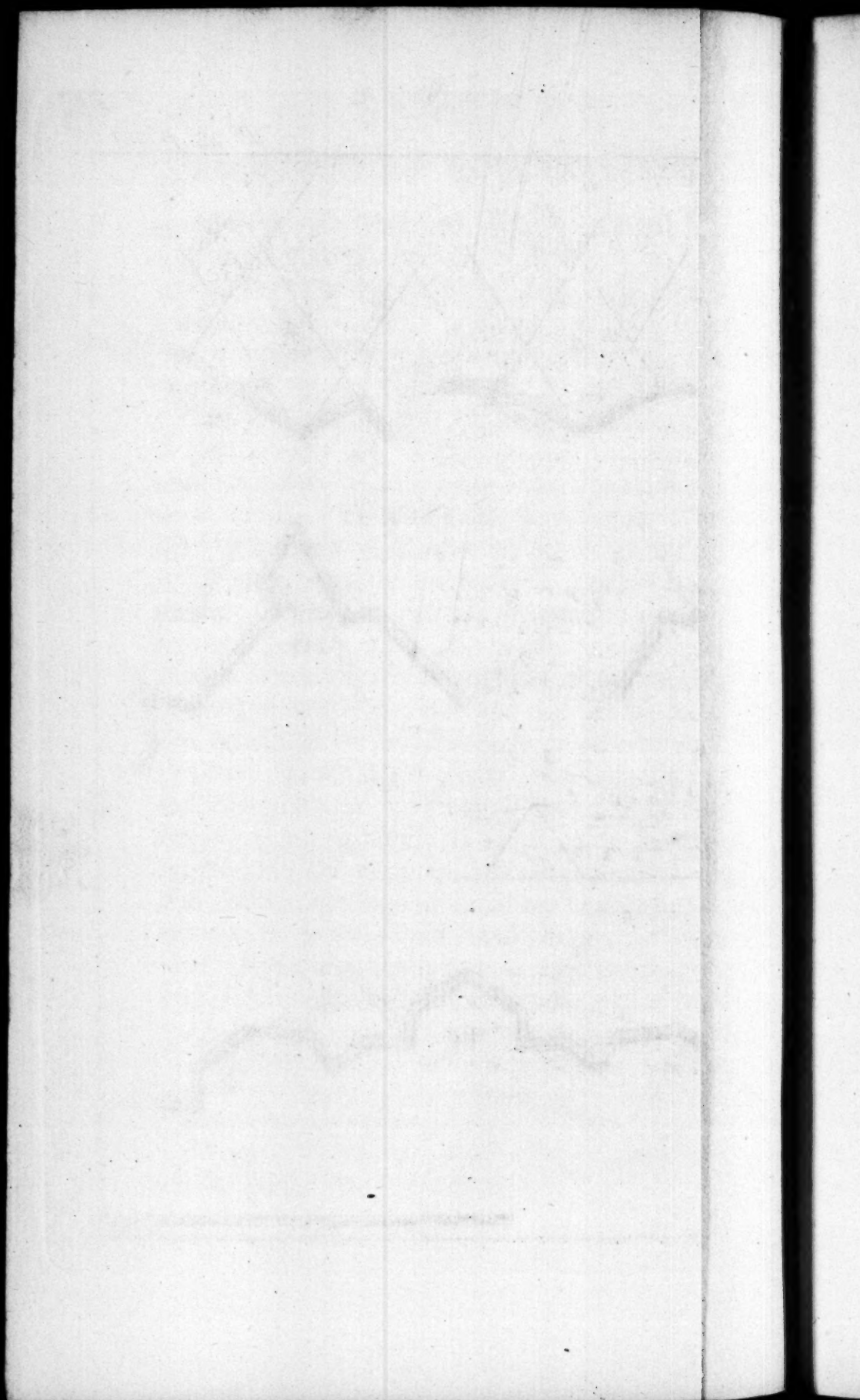
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## OBSERVATIONS on the twelfth chapter.

I shall only add a few remarks, to what is said in the fifth article concerning retrenchments upon a hill or rising ground. The author does not seem to think, that a sudden rise is so advantageous as it is commonly supposed, because the soldiers cannot fire upon the assailants without discovering themselves too much: but in such a case, the parapet of the intrenchment need not be so high than on level ground, and made with a steep slope or glacis; besides, wherever there is a favourable spot of ground flanks are made: but suppose the enemy attacks, he must receive a grazing fire along the slope without being able to return it; and if the foremost should come so far as the line, will not a greater body of troops oppose him, with all the advantage possible, while his front rank only is able to fire. It does not appear to me, that such an attack is at all practicable provided the defenders stand their ground. It is true, attempts of that kind have been made, but never answered that I know of; on the contrary, after several extraordinary efforts have been made, the assailants have been obliged to retire, after having lost the greatest part of their best troops.

## CHAPTER THE THIRTEENTH.

- I. *Profils.* II. *Reflection and example.* III. *Defects of profils too much elevated.* IV. *Observations on the author's breaks.* V. *height of parapet.* VI. *Their thickness.* VII. *Their pent or slope.* VIII. *Their interior height.* IX. *Banquets and their slopes.* X. *Ditches and advanced ditches.* XI. *Other slopes, and their berm.* XII. *Glacis and covert-way.*

I. **I**T is not sufficient to give a work the most convenient figure in regard to the nature and quality of the ground, to defend its access; we must also know what should be its height, and every dimension proper for each particular part, and this is what we comprehend under the name of a profil. This is an essential point, not only in the execution, that each part may produce all its intended effect, but often in projecting a figure; for if we only follow a plan we may be led into an error. For example, the breaks I have proposed in many places, to distribute the fire equally, and give it a better direction, effectually procure that advantage, and in the plan, appear out of the critick's reach, yet we shall find in article 4. that they are not without inconveniences in the elevation. This important part, on which we seldom sufficiently reflect, being relative to the

the whole, shall be the subject of this chapter, and the conclusion of this treatise.

II. I will begin by observing in general that an intrenchment too weak, tho' well disposed in every other respect, should rather shew us the necessity of a remedy, and the danger, than encourage us with false notions. On these occasions the soldier always measures by his eye the greatness of the obstacles the enemy must surmount to come at him; and if they do not appear sufficient, his steadiness diminishes, or he is discouraged: it is seldom that we defend ourselves as well as we might, when not supported with the hopes of conquering or driving back our adversary.

An engineer therefore must not fear making large profiles, when circumstances require it, and he has the means to execute it. M. *Vauban*, complaining of the negligence of the *French*, in his memoirs of sieges, would have us make two or three banquets to the lines of circumvallation, and oftener three than two, so that the parapet be raised enough to be fraised, and to cover the cavalry; and either in regard to the shortness of sieges, or rather for the reason we shall explain, he reduced them to one banquet only in his treatise of the attac of places; we must observe that it was by no means to save work, since in profiles which he proposes against succours, that is to say, in cases where we are afraid of being attacked and forced, he



makes the ditches from 16 to 20 feet broad, and 8 or 9 deep.

What that great engineer tells us on this head, is too decisive to pass by unnoticed here. He says, that *Maurice* and *Frederick Henry*, princes of *Orange*, applied themselves so strongly to their lines, that they employed whole months in their construction, and that they made them so strong, that tho' they were often attacked, they were never forced; that they also added particular forts at certain distances from each other, and according to the practice of those times they fortified their quarters separately, and advanced works on the most exposed places to stop the enemy, and thus give time to the troops to arrive from the neighbouring quarters to the assistance of the menaced part: precautions which have always baffled the enemy's designs, and often endangered their being beat in their retreat. The examples of such able generals, related by such an author, will doubtless be of more weight than what can be farther alleged.

III. Having thus shewn the importance of giving a good profil to field-fortification, we will inquire what dimensions are most proper for them. An height of 9 or 10 feet, as *Vauban* demands, requiring three banquets, that the parapet may cover the cavalry, has without doubt its advantages, since such lines may be fraised, and serve instead of epaulements, and are more difficult for the enemy  
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to mount : yet this general has since fixed the height of the crown of the parapet, of his greatest profils, at 7 feet and a half, even where the excavation of the ditch would have allowed an addition, without an augmentation of work : he did not apparently make this alteration without good reasons, I will therefore endeavour to find them out. We cannot but improve by studying the motives of so great a master.

We have seen the advantages of a grazing fire in chap 12 ; and that the more it is fichtant, or inclining to a perpendicular, the less hurtful it is : but it is always more fichtant in proportion to the greater height, at least, as we observed, when the ground we defend is not parallel to the lines of fire.

Every elevation beyond \* 4 feet 4 inches, which is the height at which a soldier of a middle standard holds his piece to fire right before him, or parallel to the horizon, is therefore always a defect, which must be diminished as much as possible,

Supposing on the contrary it is 9 or 10 feet high, and one foot in a fathom slope or plunge, the small arms, by following this direction, cannot reach the ground nearer than 9 or 10 fathoms from the spot they fire, from whence arises a much greater defect,

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\* The reader must here observe that one foot *Paris* makes one foot and half an inch or 6 lines, *Engish* measure; this difference, though inconsiderable in the plans, is of great consequence in the profil.

*viz.* that the enemy will find himself covered from the direct fire, in proportion as he approaches the counterscarp, near which he will be out of all danger.

We may indeed remedy this defect, as we shall shew, but the first always subsists, and increases in proportion to the depth of the ditch, which forms new inconveniences.

As the bottom of the ditch is not seen direct, it is an unavoidable evil, and so evident that it is needless to quote it, but this must be endeavoured to be remedied by the flanks. It is not with field fortification in this respect, as with places; the ditches of the latter, if well constructed, are seen in all parts; whereas in field fortification, the ditch is much narrower and parallel to the parapet, and in certain places cannot be seen from any part.

These defective parts, in common lines, are along the faces of the redans beginning at the reentrant of the counterscarp: the ditch cannot be seen there but from the extremity of the curtain; and it is plain that the extent, which cannot be discovered from thence, not only increases by its depth, but also by the greater elevation of the parapet. These are, if I don't mistake, the motives that induced *Vauban* to lower his profiles; I should have been inexcusable if I had departed from the maxims of so great a man.

IV. This is the place to resume my subject, on the proposed intrenchment. One of the  
redans



redans, always discovering the foot of the next, according to the common method, there are not any of those dead, or defective parts along the curtain, which the breaks necessarily cause in all mine.

The defect is greater in proportion I own; therefore it is only necessary to know, if that is as essential as it appears, or whether it is so well compensated by other advantages, as not to reject them I shall therefore observe,

1<sup>st</sup>, That we are not commonly confined to the attac of one redan only, and if for example we include three in the attac, the two curtains which join them, have no protection to expect, each being then too much engaged in its own proper defence, to assist in that of another, thus it seems to be indifferent.

2<sup>dly</sup>, That if the curtain is attacked, as the adjacent redans will infallibly be so too, each will fire directly before itself, and in this case neither the counterscarp, nor the ditch will be defended by any thing; whereas by my method, all reciprocally flanking each other, we cannot particularly defend any one, without also defending the part we should.

3<sup>dly</sup>, That my capitals are covered by many crossed fires, that are not to be found in common lines: and to avoid repetitions, I must beg the reader to recollect what I have observed on this chapter, in the different parts of this treatise.

I shall not alledge that these dead angles

are even found in stars, and in demi-bastioned forts, and in all other works of this nature. However indispensable they were formerly it is not the less a real defect; \* and we should consequently avoid it, as much as possible, that is to say, without losing more than we gain by it.

Though this is a fact, we must own all inconvenience disappears when the ditches are full of water; my schemes have at least some advantage, in this case, and was I mistaken, I may be permitted to say, that treating on a subject so important, so simple, and yet so neglected, their variety will always be useful, and that by inciting a curiosity or emulation in those that will criticise on mine, and perhaps give birth to more happy ideas.

V. We will now pass over those preliminary reflections, to the detail of the profils, P.XXXVIour intended subject. Every intrenchment of earth, is composed of a parapet, one or more banquets, one or two ditches, and sometimes a berm, and a small glacis.

I have shewn M. *Vauban's* thoughts on the great height of profils, and the particular reasons I had for conforming to his opinion. I will therefore, with him, fix the greatest elevation at 7 feet and a half from the ground.

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\* We shall find, in the ensuing treatise, a method as plain as ingenious, to remedy such defects. It was invented by M. *de Verville*, mentioned in chap. I. Article 4.

Yet this must only be in common cases; there are circumstances, which oblige us to raise it more; such as the necessity of commanding the environs, to plunge into some low part, or to cover a branch, by raising the saliant.

Works closed at the gorge, joined to lines, must be excepted from this rule, unless when so situated, as to command the rest, which should be at least by two, or three feet. If we recollect the nature of the inconveniences which oblige us to confine the profils to this height, we shall find, that they are not always united. I will explain myself better by examples.

When we elevate a front but 4 feet, or thereabouts, above the ground we would command, it is plain we batter it with a rampant fire, though the defect of the dead part increases: on the contrary, when it is only necessary to raise a saliant to a certain height, to cover a branch, provided the reentrant preserves the determined height for the breadth of the ditch, the fire becomes more fichant towards the flanked angle, without the ditch being less defended.

We may in the first case reject the breaks, if thought necessary; that will be so much gained, especially if we can find any means of distributing the fire, as well without them; in respect to the second case, that is of fires too fichant, or plunging, that defect alone is the reason which prevents our giving the  
profil



profil that height we would to works without flanks, or to those that have them too oblique, which consequently do not defend their ditch.

I do not here speak of the cover the enemy finds against a direct fire, by approaching a work too much elevated, because that is easily remedied, as already said. A parapet should never have less than six feet elevation above the ground, without which it only covers in part those that are behind it; thus all the difference between the highest and the lowest is reduced to one foot and a half.

VI. The thickness of the parapet varies much more than the height. In regard to this, the design and nature of the work must be considered. Three feet is enough for that which is not exposed to cannon, for example, the intrenchment of a grand guard; four feet and a half is sufficient for works that cannot be battered but at a distance; the rest have 6 or 8, and even 12 feet is allowed for intrenched camps, heads of bridges, redouts, and other pieces, intended to stand a long time, or that may be exposed to a brisk fire of artillery, or a long attac.

The thickness is not exempt from a defect, but is of so little consequence, that it is scarce worth mentioning, since it consists in unavoidably shortening the branches.

I do not here speak of the reduction of the sides of polygons, inscribed in other similar figures, what I mean is more essential, at least

least in the rasant or grazing defence, since it diminishes the saliant, and consequently the protection of the flank: we must consider that what we gain by the reentrant is no defence in this respect, since it is visible, that when the flank is perpendicular, as we suppose, that which is within the line of defence, fires on that part it should graze.

The last is, strictly speaking, a great defect; we may correct it in bastioned lines, by advancing the curtain to this intersection, and more easily yet in every case, by rounding the interior of the parapet of that part, if so scrupulous an exactness was not a fault in practice, where too minute an attention to trifles often creates a negligence in more essential things.

VII. When we consider that the plunge or slope of the parapet commonly determines the direction of small arms, it is obvious, in whatever manner it is traced, it is never without inconvenience; for we do not discover the counterscarp at the bottom of the ditch, but in proportion as this slope is great, and in proportion to its increase, its direction varies from the rasant line.

These objects being incompatible, all we can do, is to find a mean between them that shall be most proper. I think this has been sufficiently treated of, in the treatise of the attac of places: we there find parapets of 6 feet thickness, which have one foot and half slope or plunge: I own this appears excessive  
to

to me, not only because the fire becomes too fichant or plunging, but also it weakens the crown, and by following this direction the soldier will discover himself too much, and, as we shall find in the next article, much more than he should do.

I would not have above 12 or 15 inches slope in a fathom, to which I will add this observation. The highest profils commonly having the deepest ditches, this additional height and depth increase, the one the cover in front on the counterscarp, and both, that in the bottom of the ditch.

We must therefore give the least plunge to the lowest and weakest parapets, and increase the others in proportion to their height, which is not at all inconvenient, for besides their greater thickness, the top cannot be battered but horizontally, and consequently with little effect.

On this account I find the slope at one foot in a fathom for profils six feet high, and an increase of one inch in every half foot, giving 13 inches to those of 6 feet and a half, 14 to those of 7 feet, and 15 inches to those of 7 feet and a half.

Thus supposing the ground level, these different fires fall equally on the ccunterscarp at 6 fathoms from the point they depart, and at a little distance from each other in the bottom of the ditch. As to profils of an extraordinary elevation, the greatest slope, that is 15 inches, appears to me sufficient.

VIII. Four



VIII. Four feet and a half is commonly allowed to the interior part of the parapet. It is a custom, so generally followed, that it seems an established maxim. This rule would have been less followed had it been more strictly examined; it is good indeed for the construction of places whose parapets sink in time, and have also much less plunge, or slope; but circumstances varying, it is plain that it cannot be proper here.

I know by myself, that a man of 5 feet 6 inches, standing as he should do the left foot 18 inches distant from the upright of the crown of a parapet four inches and a half, which is the common slope, fires with more ease horizontally, than if it had a plunge of 8 inches in a fathom. As few soldiers are of this standard, it is not surprising that so many shot are lost in the air.

There is but one remedy for this; it is not only to diminish this height, but also to diminish it in proportion to the plunge, for this circumstance is so essential, that he should be near 6 feet high, to fire over a parapet 4 feet and a half high, and 18 inches plunge in a fathom, such as mentioned in the preceding article.

I therefore think that a horizontal parapet, such as those of some communications, and other works no higher than 4 feet 6 inches from the ground, should not be more than 4 feet 4 inches, and in regard to others, they should

should be lowered in a proportion of four inches in a foot plunge.

It will without doubt be objected, that the soldier will be much more exposed; I acknowledge it, but of what service is a slope we cannot use? besides, a soldier on these occasions naturally stoops, so that more than his head is never above his firelock.

Baskets, or small gabions, such as I mentioned in article 4. of the preceding chapter, would be of great use here, since they remove all difficulties, at least, in respect to the fire of small arms,

IX. The exterior height of the parapet being regulated by the interior, and plunge, there is nothing to be said on that head.

A man in the attitude of firing does not possess much more room than two feet; three feet is then sufficient for a banquet, yet we commonly allow four and a half, that a soldier may stand behind, or pass in the rear of him that fires.

This breadth is allowed from the foot of the pallisades when there are any.

I would not have the banquet more than three feet high, it is much better to make two of two feet each than one of four, because a slope, when steep, is always easier to mount when so short.

Three feet at most is sufficient for the lower banquets, they not only serve as steps, but also to draw up the soldiers on, to relieve those that line the parapet.

The

The slopes of banquets may, also be regulated by their height; when they are only one foot, the natural slope is enough, as they have only to step a little higher on one of two feet; I allow to the base one height and a half, and two heights to those that are raised 2, or 3 feet.

In narrow places, to manage the ground, we may form steps with hurdles 12 inches high, and 9 broad, which serve instead of a slope.

X. The excessive breadth of the ditch, if it is not full of water, creates a defect in durable fortification, (or that of places) which is, that batteries on the crown of the glacis, or on the terreplein of the covert-way can, without plunging much, sap the foot of the revetement or face of the wall: but there is no reason to fear that, in these kinds of fortification.

The greater the breadth, the more advantage we reap here; the enemy is more exposed on the counterscarp; the length of the dead or undefended parts, afore-mentioned, diminish; and if the ditch is to be filled up, the work becomes more tedious, and consequently the enemy are exposed much longer to a fire very terrible because of its proximity.

We need not fear making the ditch too broad, but yet it must be regulated by the time and number of workmen allowed us, and also by the quantity of earth we have occasion for.

It is not so in regard to its depth: as in  
flanked



flanked works it naturally increases the dead parts, I would not have it exceed 7 feet and half. As to works not flanked, where no protection is to be drawn but from the parapet, also in ditches full of water, it cannot be too deep, since it always is an addition to the difficulty of access, without any inconvenience.

On the contrary, I think the depth should not be less, if possible, than 6 feet, which must be preferred to its breadth, otherwise the enemy may easily leap over, or too easily fill it up.

The distance of the advanced ditch from the counterscarp is regulated by the precautions mentioned in chap. 2. As we have seldom occasion for the earth taken from it, we make it small, and finish the little glacis beforementioned. I would have the slopes of this ditch, dry or wet, meet at the bottom; in the first case the enemy cannot stand there, and in the other, it will not be less difficult to pass: their depth must at least be 6 feet, and their breadth 7, that they may not be easily leaped over.

XI. Slopes depend on the consistence of the earth, but though we cannot determine any thing positive in this respect, it is proper to form a general rule to avoid errors.

The nearer the soldier is to the crown of the parapet, the better he can follow the direction of the slope or plunge; therefore the inside will be better to be quite perpendicular,

lar, but as this can seldom be done, we give it as little slope as possible, which is commonly about one third of the height. *M. Vauban* gives to those of the scarp and counter-scarp one third of the breadth of the ditch; I do not see his reasons for this, it is evident that the nearer these parts approach a perpendicular, the more difficult they are to ascend and descend; it is therefore by the nature of the ground, and not the breadth of the ditch, that this must be regulated. In sandy ground the scarp must consequently be a foot in a foot slope; but with strong and bold earth, two thirds, or even half may be sufficient. We cannot give it less, because this part supporting the whole parapet, may otherwise run the risk of falling down, but as the counter-scarp is not in the same situation, we may scarp it as much as possible, especially when the work is to subsist but a few days. I only speak here of dry ditches; when they are wet, or full of water, these slopes must not be so steep to allow for the waste made by the water.

We sometimes find light and poor earth, which cannot be used without danger. In this case we must not only increase the slope, but also leave a berm of 2 or 3 feet between the slope and the foot of the parapet, which berm must be rounded, that the enemy may not halt there, and take breath.

XII. I have in many places in this chapter observed, that for want of giving all the

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necessary

necessary plunge or slope to the parapet, the enemy are less exposed to a direct fire, in proportion as they advance to the counter-scarp: so essential a defect, especially in works without flanks, did not escape M. *Vauban*; he remedies this, by forming with the remainder of the earth a small glacis, which cannot be mounted, without the enemy losing this advantage.

As simple as the construction of this work is, it requires some attention; if the glacis be too high, it serves the enemy as a cavalier of the trench, to fire plunging; if it is too low, it does not produce the desired effect.

M. *Vauban* seems to have fixed this height at four feet and a half below the crown of the parapet. We should never give it more, especially if we follow his profiles, since the summit of the glacis is thus on a level with the banquet; with regard of giving it less, that must be regulated by the direction of the plunge, the only object being to discover the enemy entirely, or at least lower than the waist, when he is on the edge of the ditch; I say below the waist, that is about two feet from the ground, because they commonly sink themselves on these occasions.

The same must be observed for the slope; that is it must be such, that there be no part where a man is not seen entirely. In consequence of these maxims, the glacis is perfect, when without being too high, it is in



a line with the plunge, or slope of the parapet.

This glacis has besides this, two other advantages, one in adding to the depth of the ditch, by raising the counterscarp, the other, in partly covering the work from the fire of artillery.

We sometimes make a covert way, to redoubts, heads of bridges, and other works depending only on themselves, if their small elevation does not appear an insurmountable obstacle: in this case I would sink the counterscarp, to preserve the necessary command to the crown of the work. This loss seems more than compensated by this rasant, or grazing fire, which I draw from the covert way, and which cannot be obtained from the parapet, before the enemy are on the glacis.

The designs here referred to, will explain my thoughts; it will still be better if the crown of the glacis be level for some feet, as the fire following this direction in a flat, and even ground, will be the most advantageous in every respect.

#### OBSERVATIONS on the thirteenth chapter.

Tho' the plans of all the different works, are ever so well laid down, yet, if the profils are not well regulated, the works lose a great deal of their advantages; and as the ground is seldom on a level from

one end of a retrenchment to the other, or before it, as far as cannon-shot, a profil that is very proper in one place is not so in another, where the ground changes its level. It is therefore the engineer's duty to examine very exactly what profil is necessary, in regard to the situation: I could give many examples, where the soldiers could be seen to their very shoes, at a small distance from the parapet. The profil ought therefore to be altered not only on account of the situation of the line, but likewise on the ground before it.

When the proper height of a profil is determined, its thickness or strength must be considered next; and where cannon can be brought against it, placed nearly on the same level, or higher than that of the line, no less thickness can be given to the parapet than 12 feet, and if time will permit it should be from 15 to 18 feet, for no less can stop a cannon ball; but if the battery is lower than the level of the line, from 6 to 12 feet thick will do; since the shot will in this case fly upwards after it has hit the parapet. But in such places, where the enemy cannot bring any cannon against, a thickness from 6 to 9 feet will do very well.

When a parapet is obliged to be made very high, several banquets or steps must be made for the soldiers to mount and fire; but as the fire from a high parapet discovers the enemy

my but at a distance, and cannot hurt him when near, there ought to be flanks made if possible to scower their ditches; and besides, the slope of the parapet must be as great as is consistent with safety. This defect may likewise be remedied in part, by flinging part of the earth taken out of the ditches, on its counterscarp, in the form of a glacis, and leaving a banquet for the soldiers to stand upon, and to fire from thence, till the enemy comes close, and retire afterwards thro' the barriers. Mr. *Vauban* made his ditches usually larger than was necessary to have earth enough for the parapet, whose height he fixed at 7 feet 6 inches French measure, which makes about 8 feet of ours. In such cases, the remaining earth may be thrown on the counterscarp, as we observed before, which will make the fire grazing from the parapet, all along this glacis. And when time will permit, a second ditch with pits full of stakes, before the part of the intrenchment most easy of access, will prove a very great obstacle to the enemy in his approach.

As to the proper slope of the parapet, it intirely depends on the height of the profil, and the nature of the ground before it, but it should always be, if possible, such as to produce a grazing fire, which cannot be done when the parapet is high, without raising a glacis on the outside, as before mentioned. As the author has been very attentive in explaining



plaining the several parts of profiles, and how they are to be made according to the circumstances that may happen, I shall conclude with recommending to the reader always to have the draught before him, when he reads any part referred to them.

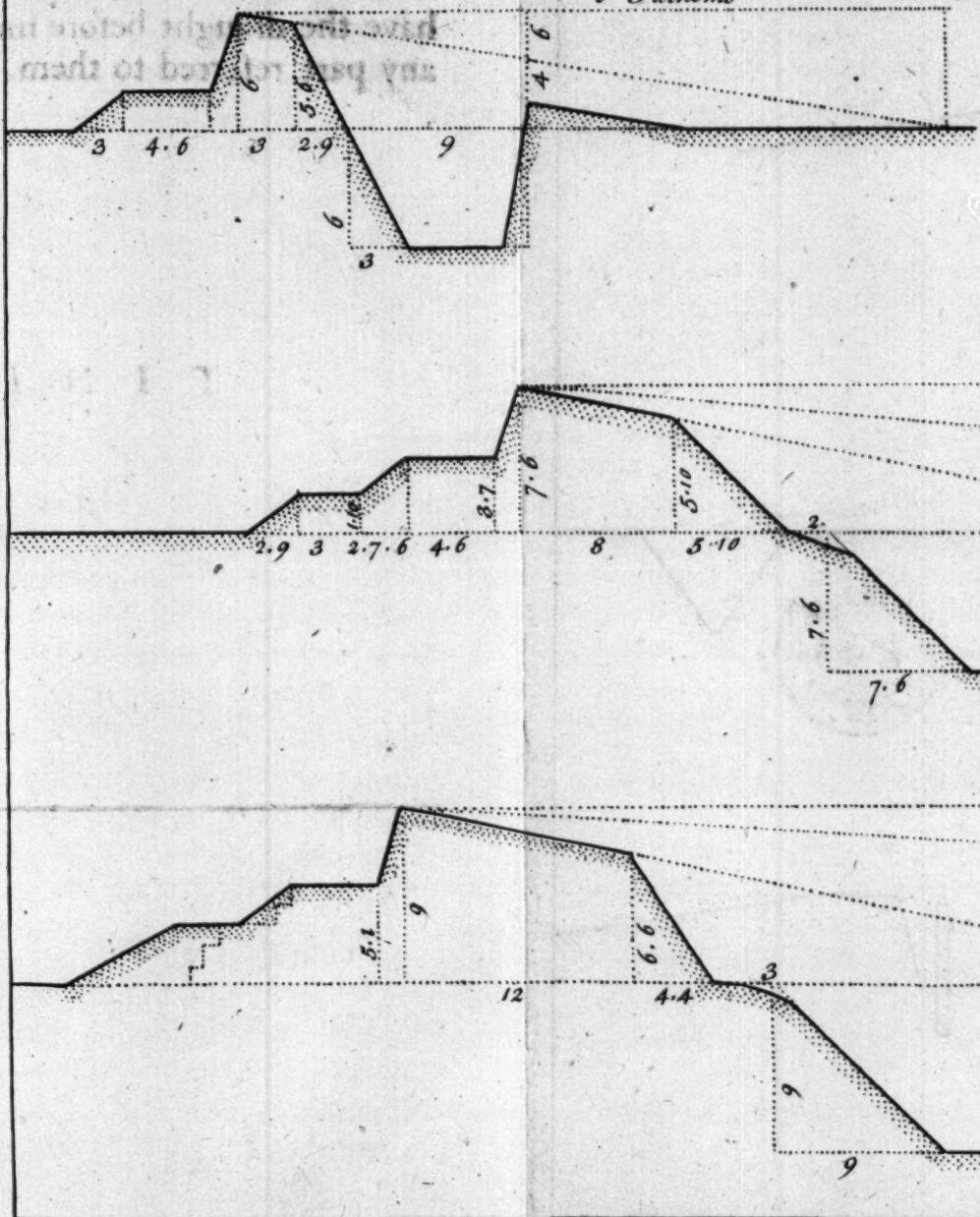


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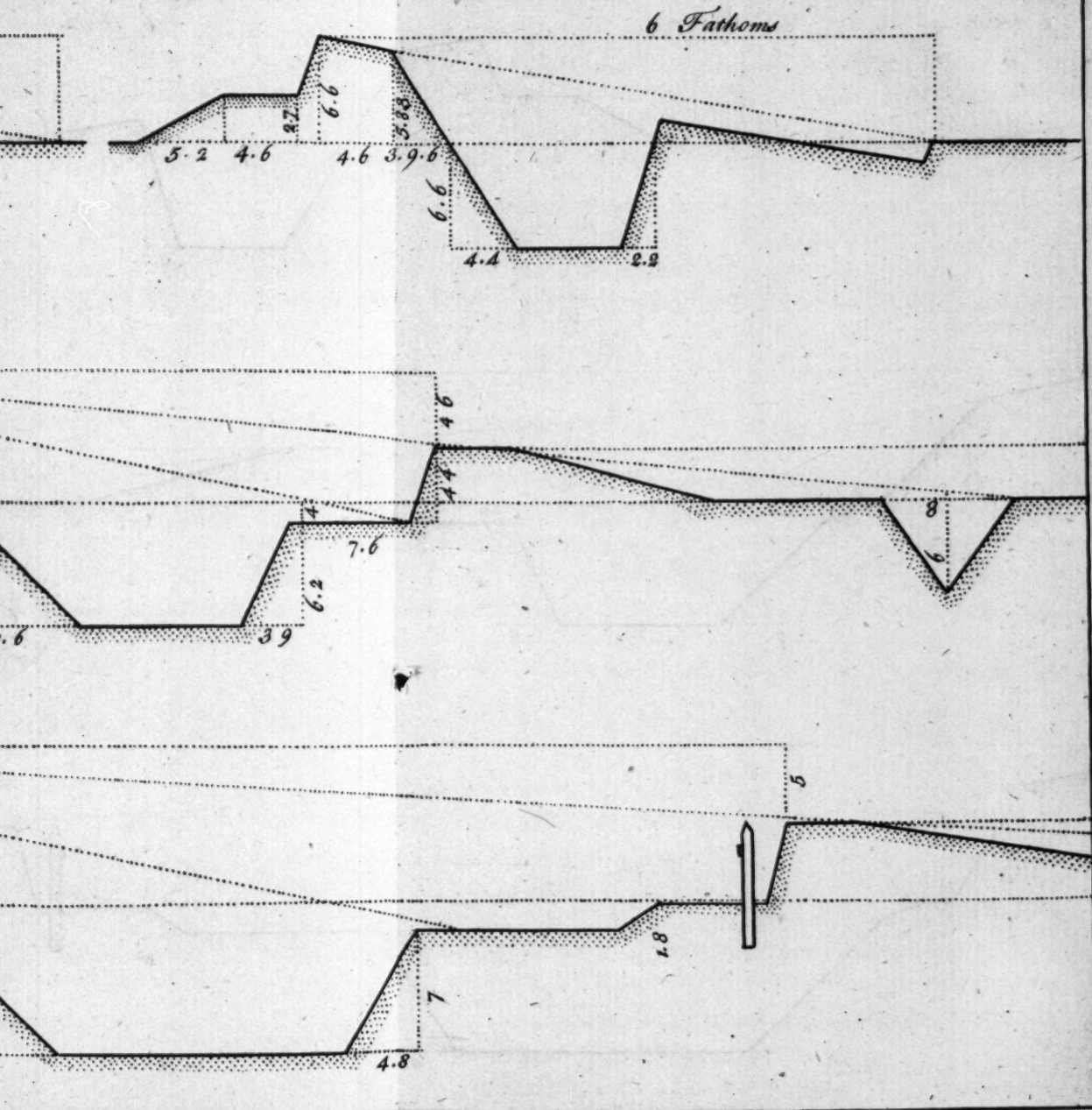
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# PROFILS

Pl. 36. p. 264.





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